...ICAL ROOM
...RAL LIBRARY
..., OF MICH.

APR 6 193

GEOGRAPHICAL REVIEW

...UBLISHED BY

THE AMERICAN GEOGRAPHICAL SOCIETY
OF NEW YORK

...PRIL
...931

OUR CONTRIBUTORS

DR. GOULD, of the Department of Geology of the University of Michigan, was geographer and geologist on the Byrd Antarctic Expedition, 1928–1930, and second in command of the expedition. Before this he had carried out work in the Arctic—on the First Greenland Expedition of the University of Michigan led by Professor W. H. Hobbs (1926) and on the Putnam Baffin Island Expedition (1927). He contributed a report on the physical geography of the latter to the January, 1928, number of the *Geographical Review*.

MR. MILLER is on the staff of the American Geographical Society's School of Surveying.

MAJOR COCHRAN-PATRICK is Director of the Aircraft Operating Company, a British organization that is a pioneer in the field of aerial survey. In addition to his work in Africa, Major Cochran-Patrick has engaged in aerial survey in South America, Burma, and the Middle East.

MR. WILSON is geologist of the Arizona Bureau of Mines, University of Arizona. For the past twelve years he has been studying the geology, geography, and mineral deposits of the state.

MR. SYKES has for many years been associated with the Desert Laboratory of the Carnegie Institution, Tucson, Ariz. He has intimate knowledge of the arid southwestern United States in both physical and historical phases. To the *Geographical Review* he has contributed "The Delta and Estuary of the Colorado River" (Vol. 16, 1926) and "The Camino del Diablo: With Notes on a Journey in 1925" (Vol. 17, 1927).

DR. JAMES is associate professor of geography in the University of Michigan. His interests are chiefly in the economic and human phases of the subject, and he has engaged in field work in various parts of Latin America, most recently, 1930–1931, in Brazil. He is the author of college texts (available in mimeographed form) and of numerous articles. To the *Annals of the Association of American Geographers*, June, 1929, he contributed a study of "The Blackstone Valley" in New England.

DR. WHITE is head of the Geography Department at Randolph-Macon Woman's College, Lynchburg, Virginia. Since 1925, when he was a member of the faculty of the University of Pittsburgh, he has been carrying on a series of field investigations in the principal iron and steel districts of the country.

MR. FOSCUE is assistant professor of geography at Southern Methodist University. His writings include "Rainfall Maps of Cuba" in the *Monthly Weather Review*, May, 1928, and "The Mesilla Valley of New Mexico: A Study in Aridity and Irrigation" in *Economic Geography*, January, 1931.

DR. PEACOCK is assistant professor of geology and geography at the University of British Columbia. He has made geological and physiographic studies in Iceland (1924), the Faeroes (1925), and the Columbia River Plateau (1927).

DR. WOLFANGER, instructor in economic and soil geography at Columbia University, was for many years associated with the staff of the U. S. Bureau of Chemistry and Soils. He is the author of "The Major Soil Divisions of the United States" (1930), and to the *Geographical Review* he contributed "Major World Soil Groups and Some of Their Geographic Implications" (January, 1929).

DR. RAISZ is instructor in cartography and physical geography in Columbia University. He is also connected with the American Association of Museums, doing work for the National Parks. "Physiography of Mount Desert Island" was published in 1926. He has done cartographic work for the Third Asiatic Expedition of the American Museum of Natural History and other expeditions and has carried out geologic field work in Cuba.

THE GEOGRAPHICAL REVIEW

CONTENTS FOR APRIL, 1931

	PAGE
Some Geographical Results of the Byrd Antarctic Expedition *By Laurence M. Gould*	177
Planetabling from the Air: An Approximate Method of Plotting from Oblique Aerial Photographs *By O. M. Miller*	201
Aerial Reconnaissance Mapping in Northern Rhodesia *By Major C. K. Cochran-Patrick*	213
New Mountains in the Yuma Desert, Arizona *By Eldred D. Wilson*	221
Rainfall Investigations in Arizona and Sonora by Means of Long-Period Rain Gauges *By Godfrey Sykes*	229
Vicksburg: A Study in Urban Geography *By Preston E. James*	234
The Iron and Steel Industry of Sparrows Point, Maryland *By Langdon White and Edwin J. Foscue*	244
The Modoc Lava Field, Northern California *By Martin A. Peacock*	259
Economic Geography of the Gray-Brownerths of the Eastern United States *By Louis A. Wolfanger*	276
The Physiographic Method of Representing Scenery on Maps *By Erwin J. Raisz*	297
Twenty-Seventh Annual Meeting of the Association of American Geographers	305
American Geographical Society	308
Geographical Record (*listed on the next page*)	316
Geographical Reviews (*listed on the next page*)	334

The Society is not responsible for the opinions or statements of writers in the Review

PUBLISHED QUARTERLY BY THE AMERICAN GEOGRAPHICAL SOCIETY
BROADWAY AT 156TH STREET, NEW YORK, N. Y.

Price, $1.25 a number Five dollars a year

Entered as second-class matter, January 22, 1916, at the Post Office at New York, N. Y., under the Act of August 24, 1912

Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized on July 30, 1918

GEOGRAPHICAL RECORD

NORTH AMERICA

Mexican Immigration to the United States 316

Manhattan Maps 317

Pennsylvania Caves. *By W. M. Davis*.... 318

SOUTH AMERICA

Winds at Chuquicamata, Chile. *By W. E. Rudolph*..... 318

AFRICA

The Region of the Great Shotts and the Question of Atlantis. *By E. F. Gautier* 319

ASIA

Geomorphology of Western Tibet. *By W. M. Davis*..... 321

Sir Aurel Stein's "Innermost Asia" and Supposed Climatic Changes in Central Asia..... 321

The Climate of Indo-China..... 324

POLAR REGIONS

Antarctic Circumnavigation by the "Norvegia" 325

Progress of Sir Douglas Mawson's Antarctic Expedition, 1930–1931..... 326

Meteorology of the British Antarctic Expedition 1907–1909. *By Griffith Taylor* 328

PHYSICAL GEOGRAPHY

Ocean Waves. *By H. A. Marmer*..... 329

HUMAN GEOGRAPHY

World Illiteracy..... 330

The World's Salt..... 331

OBITUARY

Otto Sverdrup..... 332

José Toribio Medina..... 333

GEOGRAPHICAL REVIEWS

C. K. LEITH. **World Minerals and World Politics: A Factual Study of Minerals in Their Political and International Relations.** *By A. C. Veatch*..... 334

HAROLD A. INNIS. **The Fur Trade in Canada: An Introduction to Canadian Economic History.** *By Charles C. Colby* 336

SAMUEL HUNTINGTON HOBBS, JR. **North Carolina: Economic and Social**..... 337

H. B. KINNISON. **The New England Flood of November, 1927.** *By J. W. Goldthwait* 338

Maine Rivers and Their Protection from Possible Flood Hazards. *By J. W. Goldthwait*..... 338

E. S. CULLINGS AND ALLEN HAZEN. **A Report on the Control of Floods in Northern New York Rivers.** *By J. W. Goldthwait*..... 338

S. BATKY, A. BERZEVICZY, AND OTHERS. **L'Ungheria.** *By E. D. Beynon*..... 340

Oceanic, Continental, Mediterranean and Boreal Climatic Influences and Mountain Climate in Europe as Synthetised and Represented by Characteristic Plants. *By W. O. Blanchard*..... 341

Rzeczpospolita Polska Atlas Statystyczny (La République Polonaise Atlas Statistique). *By Eugene Van Cleef*..... 341

STEN DE GEER. **Människans och Näringslivets Geografi.** *By Nels A. Bengtson* 342

L. DUDLEY STAMP. **Asia: An Economic and Regional Geography.** *By G. T. Renner*..... 343

HANS VOGEL. **Die atmosphärische Zirkulation über Australien.** *By R. DeC. Ward* 343

OLAF HOLTEDAHL. **On the Geology and Physiography of Some Antarctic and Sub-Antarctic Islands, with Notes on the Character and Origin of Fjords and Strandflats of Some Northern Lands.** *By G. W. Tyrrell*..... 345

W. CAMPBELL SMITH, edit. **Report on the Geological Collections Made During the Voyage of the "Quest" on the Shackleton-Rowett Expedition to the South Atlantic & Weddell Sea in 1921–1922.** *By G. W. Tyrrell*..... 345

T. N. KRABBE. **Greenland: Its Nature, Inhabitants, and History**..... 346

WILLIAM THALBITZER. **Légendes et chants esquimaux du Groenland**..... 346

W. H. HOBBS. **Exploring About the North Pole of the Winds.** *By James H. Kimball*..... 347

SIEGFRIED PASSARGE AND OTHERS. **Stadtlandschaften der Erde.** *By Robert Burnett Hall*..... 348

Hermann Wagner Gedächtnisschrift: Ergebnisse und Aufgaben geographischer Forschung..... 349

DOUGLAS CARRUTHERS, edit. **The Desert Route to India**..... 351

JOHN LOSSING BUCK. **Chinese Farm Economy.** *By George B. Cressey* 352

THE
GEOGRAPHICAL REVIEW

VOL. XXI APRIL, 1931 NO. 2

SOME GEOGRAPHICAL RESULTS OF THE BYRD ANTARCTIC EXPEDITION

Laurence M. Gould
University of Michigan

[With separate map, Pl. I, facing p. 194]

DURING the course of my duties as geographer and geologist of the Byrd Antarctic Expedition I had the opportunity to make a special study of three major features—the Rockefeller Mountains, the segment of the Queen Maud Mountains charted by the geological party, and the Ross Shelf Ice. It is with these features that we are here concerned.[1]

The Rockefeller Mountains

Of necessity the major part of the expedition's first summer in the Antarctic was consumed by the business of establishing permanent quarters—Little America. Commander (now Rear Admiral) Byrd did, however, find time to make a number of flights eastward over and beyond King Edward VII Land. On the first of the flights, January 27, 1929, he discovered a new range, which he named the Rockefeller Mountains. In view of the fact that hitherto the only known land in this sector of the Antarctic was the scattered group of low-lying peaks known as the Alexandra Mountains, this discovery was of potential importance, and it was most desirable to make of it at least a brief reconnaissance during our first summer. Unfortunately the season had become rather far advanced before it was practicable to undertake this venture. On March 7 Bernt Balchen, Harold June, and I took off for the mountains. After a flight of two hours and ten

[1] For a general summary of the work of the Expedition see W. L. G. Joerg: The Work of the Byrd Antarctic Expedition 1928–1930, American Geographical Society, 1930. Also *idem:* Brief History of Polar Exploration Since the Introduction of Flying, *Amer. Geogr. Soc. Special Publ. No. 11*, 1930, 2nd edit., pp. 11–20.

Copyright, 1931, by the American Geographical Society of New York

minutes in a direction a little north of east and against a fairly strong head wind we landed near the southern extremity of the group. We were out early in the morning; but the wind began to rise as the day drew on, and about noon we had to stop our surveying. A lull in the late afternoon enabled us to make our first ascent of the mountains.

FIG. 1—Aerial view of the main group of the Rockefeller Mountains. (Photograph by A. C. McKinley.)

For the next three days and nights we were occupied in a strenuous struggle with the wind. On the morning of the 13th calm though not clear weather permitted a return to surveying. We climbed the peaks near by, completed our triangulation, and collected a fairly representative number of rock specimens. On the 14th the wind came on stronger than ever. All precautions and efforts to save the plane were futile. In the late evening a sudden gust tore the plane loose from its moorings, lifted it bodily into the air and literally flew it tail foremost for more than half a mile and dropped it onto the ice a total wreck. On the 18th Commander Byrd with Dean Smith and Malcolm Hanson arrived to bring us back to Little America. June and Balchen returned to Little America with Smith, while Commander Byrd, Hanson, and I remained at the mountains to be picked up on a second flight on the 22nd.

To anyone expecting a great mountain range the Rockefellers are rather disappointing. They are a group of low-lying scattered peaks and ridges almost completely smothered with snow. Many of the smaller masses are completely covered and appear only as bulges in the otherwise almost level surface, and even the largest mountains show but scant exposures of bare rock. The peaks and ridges range in height from about 500 to slightly over 2000 feet above sea level.

They begin roughly in latitude 78° 14′ S., longitude 155° 15′ W., and extend northeastward as a crescentic-shaped group with the crescent opening toward the west. Their most northern limits are in latitude 77° 35′ S., longitude 153° 5′ W.

From the air the bare rock surfaces looked so pink and of such a

FIG. 2—Typical view in the Rockefeller Mountains.

solid uniform color that I at first thought the mountains were composed either of trap rock or sandstone. Such was not the case: the main body of rock is a coarse-grained pink granite. A few pegmatite dikes and veins have intruded the older granite. In places it is also shot through with dikes of gray granite and pink granite differing from the main mass primarily in structure only. There are a few narrow quartz veins; and these, like the pegmatites, are barren of any interesting or important mineralization.

In sheltered places bits of gray lichens and a greenish mosslike growth were found. Unfortunately our specimens of the latter were lost when the plane was blown away, and we were not able to find any more on further search.

There is apparently a great deal of melting about these mountains during the warmer months. In many places their upper slopes are encased in a thin rind of blue ice, while great fields of ice formed from the freezing of slushy snow extend in places from seven to ten miles from the mountains. Curious circular patches of darker ice from a few inches to two or three feet across, caused by rocks burying themselves through absorbed heat during the summer months, give to these fields a freckled appearance. A real lake, about three miles in diameter, which at the time of our visit was frozen into solid blue

ice, had been formed on the southern side of the mountains, evidently by the accumulation of meltwater from the higher slopes.

We found no crevasses indicating any glacier-like movement around the mountains; probably their tops were formerly overridden by ice, but only a mildly erosive effect resulted or else weathering has been amazingly rapid here. We looked in vain for such evidences as scratches, striations, and erratics. The terrain about the mountains averages not more than 300 feet above sea level; and one gets the impression that, were the snow to disappear, what we now call a mountain group would become an archipelago.

So far as the origin of these mountains is concerned, their relief is not due primarily to tectonic disturbance. They appear rather to have been left by the erosion of materials around them—peaks and ridges of circumvallation. I believe the Alexandra Mountains to the northward, to which the Rockefellers appear to be at least petrographically related, belong to the same integral land mass and likewise owe their relief primarily to the forces of erosion.

No analyses or petrographic studies of the rocks brought back from the Rockefeller Mountains are yet available. These may establish some positive relationships with the rocks across the Ross Sea. I think this is doubtful. At any rate these mountains show no definite structural affinities with other known lands in the Antarctic.

The Queen Maud Mountains

The plans[2] for our geological reconnaissance of the Queen Maud Mountains were made in the light of what was believed to be the geographic outlines of this sector of the Antarctic as revealed by Amundsen. He had reported appearance of land between latitudes 81° and 82°, roughly in longitude 159° W. He had further believed that the Queen Maud Mountains trended southeast from Axel Heiberg Glacier, crossing the continent only some 140 miles from the pole itself. Finally, he indicated a great highland beginning in the Queen Maud Mountains in about latitude 85° 45′ S., longitude 160° W., extending thence northeast at least to 84°, and possibly connecting somewhere with the appearance of land between latitudes 81° and 82°. This highland he called Carmen Land.[3]

The geological party planned to do specifically three things. First, to sledge directly southward from Little America to the foot of the Queen Maud Mountains and there ascend Mt. Fridtjof Nansen with a view to getting a cross section of the range; second, to sledge eastward from Axel Heiberg Glacier along the foot of the Queen Maud Mountains to their junction with the supposed Carmen Land—this

[2] Details of the preparations and the incidents of the trip itself are described in Chapters 11 and 17, the latter contributed by the writer, of Admiral Byrd's narrative, "Little America," New York, 1930.

[3] See Joerg, Work of the Byrd Antarctic Expedition, p. 56, footnote.

seemed vastly important, for Amundsen's plotted position of Carmen Land indicated a highland running practically at right angles to the trend of the main Queen Maud Mountains, a curious and unnatural-seeming relationship; third, on the way back toward Little America to make a detour eastward to investigate the land indicated by Amundsen between latitudes 81° and 82°.

On its way southward the supporting party was first to pass to the westward of this supposed land. They failed to see it. The geological party, which followed soon after, found no evidence of it; and finally, on the flight to lay a cache of oil and gas at the foot of Axel Heiberg Glacier preparatory to the polar flight, Commander Byrd and his party corroborated these observations. Our plans were then altered to the extent that we did not leave the trail homeward bound. Otherwise they were carried out in their entirety and with more time at our disposal than we had hoped to have.

The Sledge Journey of the Geological Party

To accomplish so long a journey it was necessary for us either to make a preliminary depot-laying trip or to have an additional unit help us move our heavy loads some distance southward from Little America. The latter plan was adopted for conservation of time. The so-called supporting party, composed of Arthur Walden, leader, Christopher Braathen, Joe de Ganahl, and Jack Bursey, preceded us for 200 miles and established depots of food and fuel every fifty miles. On November 4 the geological party took its final departure from Little America. There were six of us—Norman D. Vaughan, dog driver and in general charge of the dogs, Frederic E. Crockett, dog driver and radio operator, George A. Thorne, dog driver and topographer, Edward E. Goodale, dog driver, John S. O'Brien, dog driver and surveyor, and myself as geologist and navigator.

We proceeded southward, keeping as nearly as possible on the meridian of longitude 163° 31′ W. From Little America to the foot of Liv Glacier we passed over two features of some geographical note; otherwise this part of our trek contained little that was novel. The first matter of interest was the fact that at 25 miles south of Little America we found ourselves going up a fairly gentle slope. From an altitude of 200 feet above sea level at the station we ascended gradually to 895 feet above sea level at 50 miles, and we were not yet on top of the hill. We had but crossed diagonally the northern end of a great gentle bulge in the shelf ice. Its axis trended southeast to northwest, and we estimated it to be at least 50 miles long. We conservatively judged that this hill must attain a height of at least 1000 feet at its highest point. Except for this bulge there are no significant changes in level of the shelf ice between Little America

FIG. 3—Outlet of Liv Glacier, showing system of crevasses. (Photograph by A. C. McKinley.)

and some fifteen to twenty miles from the foot of the mountains. It presents on almost every hand a featureless plain of dead monotony.

There seems little question but that this hill indicates a place where the shelf ice is held up and back by land. Crevasses to the west of it and even to the southwest where we came down from its slope onto the general level of the shelf indicate that there is some movement of the ice about it.

THE CREVASSED AREA

The second area of more than passing interest in this first leg of our journey was the crevassed region between latitudes 81° 10′ and 81° 17′ S. Amundsen described an eerie passage through this region, and both the supporting party and we of the geological party often found ourselves holding our breath as we threaded our way through the crevasses. As we approached this region from the north we first came upon old crevasses long since dead and now filled with snow

FIG. 4—Mt. Fridtjof Nansen, in the background. (Photograph by A. C. McKinley.)

and ice. Next we found ourselves in a region of partially filled crevasses which here and there expanded into circular depressions from five to fifteen feet across. They were not unlike symmetrical sink holes in appearance. A few haycock-shaped mounds were noted here, but their number increased farther south where the crevasses gave evidence of being much younger. Some of these haycocks had steep sides and a beehive-like configuration. These were generally thin-skinned, and some could be broken with a ski stick to reveal a great chasm below. Apparently the circular sink-hole-like depressions represent the site of these thin-skinned haycocks. The faulted-dome type of haycock with a flatter, more conical profile was present in larger numbers than the beehive type.

On the southern edge of this region we found newly formed cracks from a few inches to more than a foot in width. Camped here for the night, we soon became aware that all was not quiet around us. The ice was cracking about and under us, sometimes with

FIG. 5

FIG. 6

FIG. 7

FIG. 5—*Sastrugi* on the shelf-ice surface near the mountains. The ski stick gives a scale.

FIG. 6—Hard pebbled or ripple-marked snow surface near the mountains.

FIG. 7—Crevasses in Liv Glacier. (Photograph by A. C. McKinley.)

detonations like distant cannon and again with sharp reports like rifles fired close by. Occasionally the tent itself would be jarred as the ice snapped. I timed these reports with my stop watch and found that they averaged one a second for about twenty minutes, when I fell asleep. When I awoke three or four hours later and again listened, I was amazed to hear not a sound of any sort for many minutes. It appeared that even though the shelf ice is here at least 700 feet thick it was under such a great strain that even the weight of our outfit was enough to disturb its equilibrium and start it cracking. This camp was really well to the south of the very badly crevassed portion. At a later time we found ourselves camped in the midst of crevasses and chasms toward the northern edge of this interesting region. I took special notice to see if our previous experience would be repeated. It was not. We heard not a sound of cracking ice. Apparently the active movement of the ice is from the south, as the shapes of the crevasses would suggest, while the ice' becomes stagnant toward the north. A study of the aerial photographs

taken over this region indicates a movement from the southeast. These photographs further revealed the fact that the whole broken area is but some 75 miles in length.

Seventy miles north of the Queen Maud Mountains on our homeward way the performance described above was duplicated. There was a constant cracking of the ice all about us when we turned in but never a sound when we woke in the morning. Here, however, were no surface indications of the great strain that the ice is under; the surface is practically level, and we found no crevasses within fifteen miles on either side of this camp.

Frequently in the course of the summer we found ourselves camped among the crevasses near the mountains and even on the glaciers themselves, but in no other places than the two noted above were we thus noisily saluted.

Approach to the Mountains

From Depot No. 4 at 81° 43′ S. we now pioneered the way, establishing depots every 50 miles. We had planned to go directly south to Axel Heiberg Glacier, but at Depot

Fig. 8

Fig. 9

Fig. 10

Fig. 8—Rock face between Liv and Axel Heiberg glaciers.
Fig. 9—Glaciated top in longitude 157° W.
Fig 10—Glaciated mountains in the front ranges of the Queen Maud Mountains in longitude 157° W.

FIG. 11—Axel Heiberg Glacier with Mt. Fridtjof Nansen on the right, Ruth Gade on the left, and Don Pedro Christophersen in the middle.

No. 7 at 84° S. we changed our course fifteen degrees to the west and thus proceeded directly to the foot of Liv Glacier. From about fifteen to twenty miles from the mountains the terrain departed from the generally level habit it had presented. Gentle rolls with a few crevasses began to appear. The rolls were so gentle and so far apart that I did not realize the change in surface until I looked behind to see dog teams disappearing in the hollows to reappear again on the rolls. These first undulations were not more than ten to twenty feet high, and some must have been nearly a mile apart. But as we neared the mountains the wrinkles became more pronounced and closer together. Crevasses became more widespread, more persistent, and longer. At no other place in the course of our travels did we see a system of crevasses showing such an extensive and regular development as these below Liv Glacier. On the polar flight Commander Byrd had dropped us a number of aerial photographs that Captain McKinley had taken on the base-laying flight, one of them showing a system of crevasses so regular that we all thought this particular print had been made with a celluloid grid with parallel lines scratched on it overlying the negative. Surely there could be no such regularly spaced system of crevasses anywhere! Instead, therefore, of altering our course to avoid them as far as possible we plunged headlong into the most frightfully uncertain and hazardous traveling that we encountered all summer.

As we came still nearer to the mountains we were struck by the fact that the crevasses and undulations were not crescentic to the glacier outlets. They were rather so distributed as to indicate a movement from an easterly direction parallel to the range front at this place.

We camped at the foot of Liv Glacier on December 1 and on the next day attempted an ascent. For the two or three miles of the ascent these great rolls, some of which attained a height of 500 feet, still persisted right up the glacier as though it had not been there. They seemed to have triumphed over the puny glacier flow itself: without

disturbing the symmetry of the rolls, it had but caused their surfaces to become crevassed. The aspect of the whole was like that suggested by the waves forced up a harbor or broad river mouth in the wake of a large vessel.

FIG. 12—Low-lying foothills of old Precambrian rocks with higher tabular mountains in background. Liv Glacier ahead with Mt. Fridtjof Nansen on the left.

From Little America to within fifteen miles of the mountains the shelf-ice surface had been one of varied soft snow surfaces where there had been apparently but little wind, to wide wind-swept areas with hard *sastrugi* as much as three or four feet high and always showing an east-southeast to west-northwest trend. But when we came close to the mountains the snow surface changed in places to a hard pebbled or rippled and icy surface. It seems that on occasion the snow becomes so soft and mushy that it is beaten up into these tiny ridges by the force of the wind. When we first experienced the föhnlike wind down a glacier from the mountains we at once realized how the temperature might be raised high enough to produce such an effect.

THE MOUNTAINS AND THEIR STRUCTURE

From some twenty miles away we began to form our first definite ideas about the mountains and the major aspects of their structure. We saw a great array of ragged, irregular, rather low-lying peaks backed up by great tabular mountain masses that towered far above them. The tabular mountains immediately suggested horsts; and the straight, even lines of at least some of the greater outlet glaciers looked to me like depressed fault blocks. A further striking impression of the mountains was the sharp clear-cut front of the whole range—a typical sharply defined fault-line scarp.

More intimate views of the mountains demonstrated that their topographic expression was a fairly safe guide to the character of the rocks that composed them. The foothills with their ragged outlines are composed essentially of a great mass of dark-colored micaceous gneisses and schists with smaller amounts of granites. In some places this older mass was shot through with younger lighter-colored

granites giving to the whole a fairly bizarre striped effect (Fig. 8). Pegmatitic dikes and veins are not uncommon, and in places barren quartz veins stand out sharply against the darker background. But taken as a whole the aspect is that of a dark-colored series of old metamorphics. Doubtless these rocks are Precambrian, and wherever they constitute the mountain masses they have been eroded into ragged and angular peaks. In contrast the tabular mountains owe the

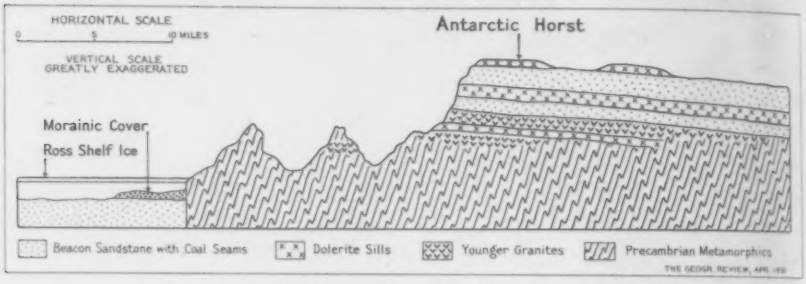


FIG. 13—Generalized cross section of the Queen Maud Mountains.

regularity and evenness of their outlines to the fact that they are capped with a great series of practically horizontal sandstones and shaly sandstones reinforced with dolerite sills. When we came near enough we could see that the tabular mountains were tilted upward toward the north, or the outer edge, so that the plateau behind is generally lower than the scarp front (see Fig. 13).

A further persistent impression was that there were almost more glaciers than mountains. Every little pocket and depression along the scarp front has its individual glacier, but it is the great valley or outlet glaciers like Liv, Axel Heiberg, and the even larger ones farther east that break up the range.

MOUNT FRIDTJOF NANSEN

We had hoped to ascend Liv Glacier far enough to reach the flat-lying rocks that top the tabular mountains. We had even hoped that we could reach Mt. Fridtjof Nansen this way. It was hopeless. We broke camp on the third of December and made our way to the foot of the glacier that takes its rise on the northwest slope of Mt. Fridtjof Nansen. Here in latitude 85° 7′ S. and longitude 163° 45′ W. we established our base camp—our Depot No. 8, called Strom Camp in honor of Sverre Strom who had helped so much in our preparations for the sledge trip. Without too much difficulty we made our way up this glacier to the rocks on the northern slope of Mt. Fridtjof Nansen and at two separate points about three miles apart climbed part way up the side of the mountain and thus got a partial cross section of these long-sought rocks.

The flat-lying sandstone series was found to rest upon the even surface of a coarse-grained gray granite. This contact zone was at 5960 feet, and the series continues upward apparently to the very top of the mountain itself—which means that it totals more than 7000 feet in thickness. Both the sandstones themselves and the underlying granites are intruded with dolerite sills, showing conspicuous vertical jointing and weathering into angular pinnacled forms in contrast to the softer outlines generally taken on by the sandstones themselves.

We climbed across a vertical exposure of 2000 feet of this sandstone series. It exhibits some variation in texture and composition, but its most characteristic aspect is that of a fairly fine-grained yellow to gray, thinly banded sandstone with scattered lenses of white sandstone up to five feet in thickness. In more massive phases it is greatly cross-bedded. It passes into dark, even black, shaly facies which contain considerable organic matter, sufficient in places to identify the rock as a low-grade coal. From one such layer Thorne brought some fragments of a hard, bright, shiny coal which burned reluctantly when a match was applied. Of course the whole sandstone series, including the highly carbonaceous layers, has been profoundly affected by the intrusion of the dolerite sills. In the vertical section that we crossed about a third of the thickness was due to the dolerite. Looking upward, one had the impression that the sills were fewer and thinner toward the top. The sandstones are almost everywhere quartzitic, and the shaly facies have been changed in places into a hard rock with almost slaty cleavage.

There is no question that this great series of sandstones and associated rocks is at least lithologically equivalent to Ferrar's Beacon sandstone of South Victoria Land. The lower portion of that sandstone, in places at least, is Devonian and grades upward into Mesozoic with the great bulk of it comprised in the Permo-Carboniferous sandstones and coal measures. I have not completed the examination of the rocks we collected, so that I am not prepared definitely to state whether they contain fossils or not. I could find none in the field.

It was on our first ascent up the slopes of Mt. Fridtjof Nansen that Edward Goodale found bits of gray lichens. In the course of the summer we found other growths even farther south than this, though they were nowhere prolific.

To have proceeded to any great altitude on Mt. Fridtjof Nansen would have been fraught with considerable uncertainty and would have consumed a great deal more time. We had determined the significance of the flat-lying cap rocks and therefore decided to turn our attention to sledging eastward along the foot of the range toward its junction with the supposed Carmen Land, whose existence we had begun seriously to doubt. This was an eventful journey.

FIG. 14

FIG. 15

FIG. 16

FIG. 14—Liv Glacier on the right, Precambrian mountains in foreground, with tabular mountains capped with Beacon sandstone in background. (Photograph by A. C. McKinley.)

FIG. 15—Horns on the ridge separating the head of Liv Glacier from the one north of Mt. Fridtjof Nansen.

FIG. 16—Top of Mt. Fridtjof Nansen, showing Beacon sandstone with dark sills of dolerite.

FIG. 17

FIG. 18

FIG. 19

FIG. 17—First big outlet glacier east of Axel Heiberg.
FIG. 18—A great granite erratic at mouth of Thorne Glacier.
FIG. 19—Mouth of Thorne Glacier.

FIG. 20—Camp Comau in Marie Byrd Land, showing dark Precambrian metamorphics intruded by younger light-colored granites and pegmatites.

Thorne undertook the task of mapping as we went along, an arrangement which left me free to devote my attention to the rocks and the glaciers.

EASTWARD ALONG THE FOOT OF THE MOUNTAINS

It was soon seen that the fault scarp of the Queen Maud Mountains proper proceeded almost due east from Axel Heiberg Glacier rather than southeastward across the plateau or bounding it as indicated by Amundsen. Furthermore, the proportion of old Precambrian ragged mountains increased, and the tabular mountains retreated farther into the plateau and became ever lower as we proceeded eastward. Likewise, the outlet glaciers became ever larger, though without being able to handle adequately the great volume of ice that flows down from the plateau and almost smothers the mountains eastward from the 150th meridian. Even so, one almost immediately discovers that the ice is much thinner here than formerly. We climbed the outlying peaks in longitude 157° and found that to heights of as much as 800 feet above the present ice level the mountain tops were rounded and polished (Figs. 9 and 10). How much thicker the ice may have been there is no way to tell. Farther eastward Supporting Party Mountain and its associated nunataks appear to have been formerly covered by the ice. This is quite different from the conditions about Axel Heiberg and Liv glaciers. Doubtless Fridtjof Nansen, Ruth Gade, and the other high mountains in this vicinity have always been high enough partially to stem even the greatest streams of ice from inland and thus prevent such extensive glaciation of the foothills as we found prevalent to the eastward.

Supporting Party Mountain marked our farthest east; and, since its location was east of the 150th meridian, we were within the sector claimed by the Commander for the United States and named by him in honor of his wife, Marie Byrd Land. His claim was based on the fact that he had flown over the newly discovered land in the latitude

FIG. 21—Front ranges in Marie Byrd Land.

of Little America. In substantiation we built a cairn on the top of Supporting Party Mountain and raised the flag. Inside the cairn we left a tin can containing a note setting forth the fact that in the name of Commander Byrd we claimed the land as a part of Marie Byrd Land.

From this mountain we could see thirty-five to forty miles farther eastward. The mountains appeared to be progressively lower. To the southeast of us the tabular mountains—the structural equivalents of Mt. Fridtjof Nansen—were not more than 8000 feet high. They define the southern boundary of the great glacier that flows down from the southeast. The whole fault structure seems to flatten out eastwards. The very large glaciers near the end of our trek coalesce to form a vast ice apron, which made travel both difficult and hazardous. The east-west-trending glacier in Marie Byrd Land pours forth such a volume of ice that it dominates the direction of flow along the whole mountain front with the result already noted in connection with Liv Glacier, namely that the flow of ice from the plateau instead of being directly northward as one might expect is toward the northwest.

Viewed as a whole the ice flow along the foot of the mountains gave the unmistakable impression that the ice is much less active now than formerly, probably when it was thicker. Most of the larger crevasses seem to have long been stagnant and to have become completely filled with snow and iced over. Throughout our journey from Axel Heiberg Glacier to Marie Byrd Land and return we heard no cracking as of ice under great strain and saw no unmistakably fresh crevasses. Ten miles beyond the mouth of one of the larger glaciers we found a great granite erratic (Fig. 18), which seemed disproportionately large to have been carried so far by the present stream of ice.

On December 20 we left Marie Byrd Land and started westward toward our base camp. On Christmas Day we quite accidentally stumbled onto what we had formerly looked for in vain—the cairn left on Mt. Betty by Amundsen eighteen years earlier when he was northward bound for Framheim from the pole. The next day found

us at Strom Camp making preparations for the return journey to Little America.

Summary of Geographic Relationships

In summary, certain geographic relationships stood out as we completed our work at the mountains:

The fault-block mountain structure of South Victoria Land is extended more than 300 miles farther across the continent than it had previously been known to exist.

Carmen Land of Amundsen, together of course with its possible connection with non-existent lands between latitudes 81° and 82°, is removed from the map.

The Queen Maud Mountains proper do not trend southeastward from Axel Heiberg Glacier. This supposed plateau range represents but the peaks that fringe the great outlet glaciers. From far out on the shelf ice we could look many miles up these glaciers, and Thorne was able to get sights on peaks along the glaciers at great distances behind the front ranges themselves. It will be noticed that Beardmore Glacier is fringed by such mountains, and it is easy to see how anyone sledging or flying some distance to the east or west of such a glacier and parallel to it would get the definite impression that he was seeing a new mountain range. Yet it is at once apparent that all of these are integral parts of the geological structure of the great Queen Maud system itself.

Though the coal measures are not coextensive with the Beacon sandstone, yet they are sufficiently so to enable us to state rather definitely that the Antarctic has coal reserves second only to those of the United States. The discovery of coal on Mt. Fridtjof Nansen and the extension of the Beacon sandstone at least to longitude 145° W. add many thousands of square miles to the coal areas already known in South Victoria Land.

The removal of Carmen Land from the map and the extension of the Ross Shelf Ice eastward at least as far as the 140th meridian in the latitude of our journey reopens the old question of the connection of Ross and Weddell Seas. Two newly observed features offer possible objections to this hypothesis—Leverett Glacier and the Edsel Ford Mountains (Pl. I). Leverett Glacier is by all odds the largest outlet glacier seen by us; and, so far as we could tell, the relatively small streams of ice that fed it from the south were insufficient to account for its great volume. Its very direction of flow suggests a source not necessarily from the south but rather from some great opening toward the east, as though there were a mountain wall in that direction. Nevertheless we could see no such structure, and it may possibly be explained by the existence of larger tributary glaciers from the

e American Geographical Society of New York

170 165 160 WEST 155

MAP

ROSS SHELF

CROWN PRINCE OLAV Mts.

Fisher Mountain

Mt. Helland Hansen

Mt. Fridtjof Nansen 2970

? Mt. Ole Engelstad 3280

? Mt. Wilhelm Christophersen 3390

Mt. Don Pedro Christophersen 3921

? Mt. Alice Wedel Jarlsberg 3848

Mt. Ruth Gade ? 3695

Mt. Alice Gade ? 3435

Helmer Hanssen ? 3275

Mt. Betty 380

Mt. Goodale 2455

Mt. Vaughan 2500

Mt. Crockett 2200

O'Brien Peak 840

Airplane cache

Sta. No 1 Nov. 30 - Dec. 2, 1929

Sta. No 2 Dec. 4-5, 10-14, 26-28

Sta. No 3, Dec. 25, 1929

Sta. No 4

Sta. No 5 Dec. 17

Sta. No 6

Sta. No 7 Var. 115° E.

Nov. 15, 1911

Jan. 9, 1912

Nov. 16 Jan. 8

Nov. 17

Nov. 18, 1911 and Jan. 7, 1912

Nov. 18

Jan. 7

Dec. 3

Dec. 24

Dec. 13-16

Dec. 23

Dec. 22

Dec. 19 Var. 116° E.

Dec. 18 Var. 118° E.

Var. 120° E.

Var. 121° E.

Var. 125° E.

Var. 117° E.

Var. 114° E.

Nov. 19

Jan. 8

Nov. 20

Jan. 6

Nov. 21

Nov. 21-25 Var. 5

Nov. 26

General direction of ice movement

AXEL HEIBERG GLACIER

AMUNDSEN

THORNE GL

Area of large crevasses

MAP OF THE QUEEN MAUD MOUNTAINS

BETWEEN LONGITUDES 175° AND 135° W.

FROM THE SURVEYS OF
THE BYRD ANTARCTIC EXPEDITION
REAR-ADMIRAL RICHARD E. BYRD IN COMMAND

Scale 1:500 000

Kilometers 5 0 5 10 15 20 25 30 35

Statute miles 5 0 5 10 15 20

Contours of ice-covered terrain, interval 200 meters (less reliable in northwestern section of map; in southeastern section to be interpreted as form lines only, with no definite interval)

Bare rock slopes and rock outcrops

4010 Elevations in meters

O'Brien Peak Names given by the Byrd expedition (all others are derived from the Amundsen expedition; not all of the identifications are certain) except Ross Shelf Ice

Route of Amundsen's South Pole party, Nov. 15 - Dec. 2, 1911, and Jan. 2-9, 1912 (R. Amundsen, H. Hanssen, O. Wisting, S. Hassel, O. Bjaaland) according to Videnskapsselskapets Skrifter I, Mat.-naturv. Klasse, Christiania, 1915, No. 5, pp. 63-64 and 67

..... Route of the geological sledge party of the Byrd expedition Nov. 30 - Dec. 30, 1929 (L. M. Gould, G. A. Thorne, Jr., J. S. O'Brien, F. E. Crockett, E. E. Goodale, N. D. Vaughan)

⊕ ① Astronomically determined positions on that route

-·-·- Approximate route of base-laying flight of Byrd expedition, Nov. 18, 1929 (R. E. Byrd, Dean Smith, A. C. McKinley, H. I. June)

..... Approximate route of South Pole flight, Nov. 28-29, 1929 (R. E. Byrd, Bernt Balchen, A. C. McKinley, H. I. June)

Polar zenithal equidistant projection

160 WEST 155 150 145

85

S H E L F

I C E

THORNE GLACIER

LEVERETT GLACIER

AMUNDSEN MTS

General direction of ice movement

Jan. 8

Sta. No. 3, Dec. 25, 1929

Mt Betty Nov. 18, 1911 and Jan. 7, 1912

Jan. 7

Dec. 23

Dec. 24

Sta. No. 4

Sta. No. 5 Dec. 17

Dec. 13-14

Var. 125° E.

Var. 121° E.

Var. 120° E.

Dec. 18

Sta. No. 6

Var. 118° E.

Var. 117° E.

Dec. 22

Dec. 19 Var. 116° E.

Sta. No. 7 Var. 115° E.

Var. 114° E.

Sta. No. 8, Dec. 20-21, 1929

Supporting Party Mts

O'Brien Peak

Mt Goodale

Mt Vaughan

Mt Crockett

Mt Ruth Gade ?

Mt Alice Gade ?

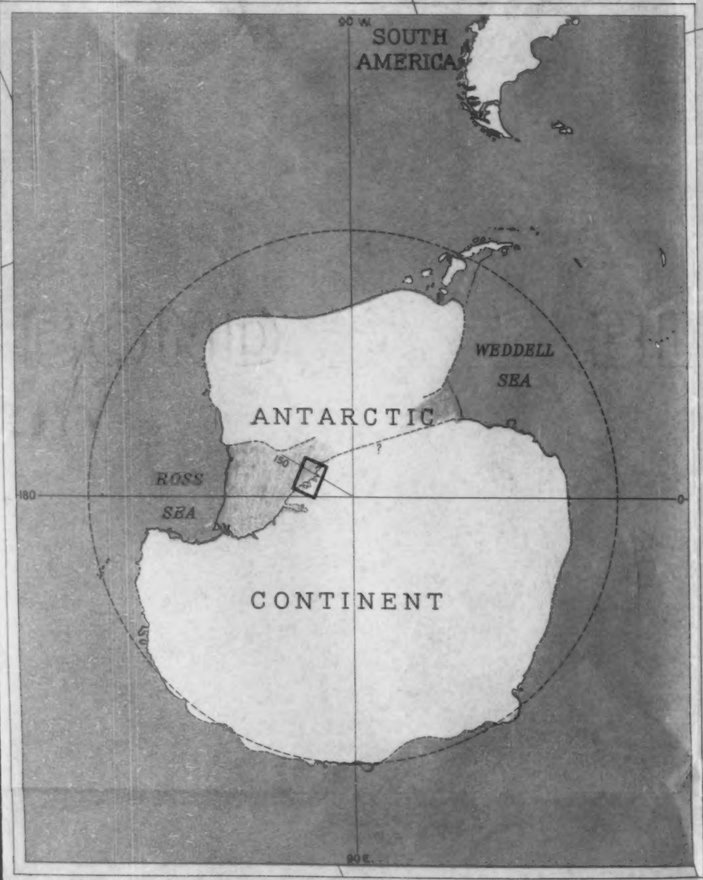
Mt Helmer Hanssen ?

Nunatak

Nunatak

Nunatak

GENERAL LOCATION OF AREA OF THE MAP



? Mt. Ole Engelstad 3280

? Mt. Wilhelm Christophersen 3390

Mt. Don Pedro Christophersen

AXEL

Nov. 21-25 Jan. 5

? Mt. Alice Wedel Jarlsberg

Mt. Ruth Gade ?

Mt. Alice Gade ?

Nov. 26

Nov. 27 Jan. 4

Nov. 28 Jan. 3

Nov. 29

Nov. 30

Dec. 1

Jan. 2

Dec. 2

DEVIL'S GLACIER

(crevassed area)

? Mt. Oscar Wisting

? Mt. Sverre Hassel

? Mt. Olav Bjaaland

SUNDSENN GLACIER

Mt. Goodale

Mt. Vaughan

Mt. Crockett 2800

Helmer Hanssen ?

THORNE GLACIER

Mt. Thorvald Nilsen

3200?

Peaks sighted by geological party

180 175 170 165 160 WEST 155 150

Copyright, 1931, by the American Geographical Society of New York

Supporting Party M

Mt. Ruth Gade ?

Mt. Alice Gade ?

Mt. Goodale

Mt. Vaughan

Mt. Crockett

Mt. Helmer Hanssen ?

UNDSENN GLACIER

THORNE GLACIER

LEVERETT GLACIER

? Mt. Oscar Wisting

? Mt. Sverre Hassel

? Mt. Olav Bjaaland

Mt. Thorvald Nilsen

3200?

Peaks sighted by geological party

ELEMENTS OF THE MAP

(The numbers correspond with those in the key diagram)

Contributed by the Byrd Antarctic Expedition

1 *Astronomically determined positions, by Laurence M. Gould, in command of the geological sledge party*

2 *Ground survey, by George A. Thorne, Jr., of the geological sledge party*

3 *Aerial photography, by Captain Ashley C. Mc. Kinley*

Contributed by the American Geographical Society

4 *Determination and adjustment of horizontal and vertical control of map from air photographs and ground survey data, by O. M. Miller*

5 *Contouring and physiographic interpretation from aerial and ground photographs, by C. B. Hitchcock*

6 *Composition and editing of map, by W. L. G. Joerg*

(The northwestern area is less reliable than the central area because the air-photographs on which it is based were taken in a way not lending itself to proper adjustment)

METHOD OF CONSTRUCTING THE MAP

The horizontal scale was determined from the positions of three astronomical stations (Nos. 1, 2, 4). From stations Nos. 2 and 4 rounds of horizontal angles to prominent features were taken during the ground survey of the geological sledge party.

The astronomical observations of the geological party consisted of meridian altitudes of the sun for latitude and two sets of time sights at each station for longitude, the error of the recording watch on Greenwich time being obtained by radio time signals.

The remaining horizontal control was obtained principally from thirty-five oblique aerial photographs taken on the flights of November 18 and 28-29, 1929. In the southeastern area, which did not appear in the aerial photographs, the horizontal control consisted only of bearings taken from stations Nos. 6, 7, 8 and from points along the geological party's route.

The basis of vertical scale relationships was a series of aneroid readings at station No. 2 to provide a datum level and observations of vertical angles to prominent features from stations Nos. 2 and 4.

The remaining height relationships were obtained from ten of the aerial photographs, the heights of the air stations and the tilts of the camera axis having been determined from the ground data.

Topography was delineated from both aerial and ground photographs and from the notes and sketch maps of the geological party.

The original work sheet was drawn approximately to the scale of 1:215,000.

The present map has afforded the first opportunity of plotting on an adequately large scale the features derived from the Amundsen expedition (see the explanatory legend under the title). The map accompanying Amundsen's book "The South Pole" (scale in Norwegian and English editions, 1:5,250,000; in German edition, 1:6,100,000) is too general to permit a precise representation. The only detailed record is the list of positions along Amundsen's route given in the publication cited in the legend above. These positions have been plotted here, and, although they are based on somewhat less accurate methods of astronomical determination than those employed by the geological party of the Byrd expedition (specifically in not having the advantage of radio time check on longitude), they agree remarkably well with the topography as here represented. Amundsen's elevations (not shown here) also agree unusually closely, with a few minor exceptions. These agreements speak well for the accuracy both of Amundsen's observations and of the present map and furnish a check on the correctness of the assumption of scale underlying the construction of the present map.

For the identification of Amundsen's peaks and other geographical features the source is his book, specifically the inadequate small-scale map in it, the rather general narrative of the text, and the accompanying photographs, the captions of which in some cases are at variance with the text in the same edition, in other cases differ among the several editions in the different languages. Under the circumstances it is obvious that some of the identifications in terms of the present large-scale map may be doubtful. These are indicated by a question mark attached to the name.

165 160 WEST 155 150 145 140 135

south beyond our vision. The nunataks east of Supporting Party Mountain help to give it a westerly flow.

The Edsel Ford Mountains beyond King Edward VII Land, discovered on the flight of December 5, 1929, were photographed from so great a distance that one cannot draw positive conclusions from the aerial photographs. But these appear to show a great range with a straight fault-line scarp that suggests the structure of the Queen Maud Mountains. It is possible that these new mountains are connected somewhere with the Queen Maud Mountains and so constitute the eastern structural boundary of the great Ross *senkungsfeld*. This of course does not necessarily follow. At any rate, what is one of the greatest questions in the geologic relationship of major structures anywhere in the world remains still to be answered—the relationship of East to West Antarctica. Investigation of the Edsel Ford Mountains would probably add important and perhaps definitive light on this question. These mountains may be not the fault-block type but a folded Andean structure, for it is in this part of the Antarctic that one would expect a continuation of the fold structures of the Antarctic Archipelago if they reappear anywhere.

The Ross Shelf Ice

Because of the fact that the journey of the geological party threw much light on it, I have left until the end any discussion of the most distinctive of Antarctic glacial features, the Ross Shelf Ice.

From the time of its discovery by Sir James Clark Ross in 1840 to this day the Ross Shelf Ice, to employ a term that seems preferable to Ross Barrier, has impressed Antarctic explorers as one of the unique works of nature. It ends on the north in a dazzlingly white cliff that stretches for 500 miles in an east-west direction roughly in latitude 78° S. It is thus the boundary of the southern navigable limits of the Ross Sea. This great snow-ice cliff prevented Ross from sailing farther south in his quest for the Magnetic Pole and hence was referred to by him as a barrier. If the term Ross Barrier is to be used at all it should refer only to the northward-facing cliff of this great sheet of shelf ice that covers well over a quarter of a million square miles.

This cliff, or barrier, varies greatly in height from place to place and from time to time. It was restudied, for the first time after its discovery, by Scott in 1901–1904. He made soundings all along its front and also measured its height above sea level. The soundings demonstrated that the water was everywhere too deep for any part of the front of the shelf ice to be resting on the bottom. He found the altitude to vary from 20 to 240 feet above sea level. The next observations were those made by the British Antarctic Expedition in 1907–1909 and indicated a height ranging from 20 to 200 feet.

When the *Terra Nova* visited the region in 1911 no spot higher than 150 feet was observed. We of the Byrd expedition made our first landing at Discovery Inlet. Here we found the height to be 60 feet. From here we sailed eastward along the shelf-ice scarp to the Bay of Whales; and, though we did not land again to make accurate measurements, there was no place along this stretch that seemed higher than at Discovery Inlet. In places it descended as low as from 6 to 10 feet. Immediately east of the Bay of Whales, in fact bounding a part of it, the height was found by measurement to be 200 feet.

Origin of the Ross Shelf Ice

Scott believed the present shelf ice to be a relict or direct descendant of the old and much greater structure formed during the period of maximum glaciation. David elaborated this idea. He described the shelf ice as being essentially a great shrunken piedmont formed mainly by the confluence of the glacial streams that flow down from the plateau and fan out.[4] These great ice streams are, in other words, ribs that flatten out away from their sources. The intervals between them have been frozen over, and snow has accumulated upon this sea ice until the whole has assumed a more or less common level.

Priestley differentiates two main methods of shelf-ice formation according to the relative importance of the basal element, whether sea ice or land ice. He believes that the Ross Shelf Ice originated chiefly upon sea ice formed in a comparatively landlocked and shoal area.[5]

It is quite impossible to estimate quantitatively the relative importance of these two sources of supply—land ice and sea ice—for the ice shelf. Unquestionably the great outlet glaciers such as Beardmore, Liv, and the rest are most important sources and are the causes of the movements within the shelf ice itself. Yet when we crossed the shelf at its widest part on our way to and from the Queen Maud Mountains we failed to observe any undulations that might represent the ribs, and we did get the very distinct impression that the greater part might have been formed essentially by sea ice becoming permanent and snow accumulating upon it. In the vicinity of the Bay of Whales we saw no evidence that glacial ice ever played a part. Not even in the overturned icebergs did we find any unmistakable glacial ice. Little America was built upon a shelf-ice bay 30 feet above sea level surrounded on the inland sides by older and higher shelf ice. According to Martin Ronne, who was with Amundsen, the Little America basin was a bay of open water with an iceberg in it back in 1911–1912

[4] T. W. E. David and R. E. Priestley: Geology (Sci. Results British Antarctic Expedition 1907–9), Vol. 1, London, 1914, p. 125.

[5] C. S. Wright and R. E. Priestley: Glaciology (British (*Terra Nova*) Antarctic Expedition 1910–1913), London, 1922, pp. 163–169 and 205–222.

FIG. 22

FIG. 23

FIG. 22—Faulting and folding in Bay of Whales. (Photograph by A. C. McKinley.)
FIG. 23—Rolls or anticlines in Bay of Whales formed by lateral pressure. (Photograph by A. C. McKinley.)

when Amundsen was established near by at Framheim. The independence of this newer piece of shelf ice is evidenced by the fact that where it merges with the older and higher shelf ice it is yet separated from it by planes of disjunction indicated either by crevasses or definitely aligned haycocks.

Changes in the Shelf Front

Scott's earliest observations showed that in places masses of ice as much as thirty-five to forty miles in width had gone out to sea since it was first charted by Ross. The whole ice front at that time appeared to have retreated some thirty miles since Ross's visit. Nevertheless, since the first surveys by Scott in 1902 the shelf-ice front or barrier does not seem to have appreciably changed its latitude; yet there have been great northward movements in parts of it. Alternate observations by Scott and Shackleton near McMurdo Sound indicate a northward movement of more than a thousand feet a year; but even here the front has remained more or less stationary. The ice is pushed forward, breaks off as bergs, and floats away. We have no measurements giving us a definite northward rate of movement anywhere else. Eastward from Discovery Inlet to the Bay of Whales our hasty observations indicated that there had been no fundamental changes in outline since the Scott survey of 1902. True enough, Discovery Inlet had a somewhat different outline from that given on Scott's charts; but it was still obviously the same bay mapped by Scott.

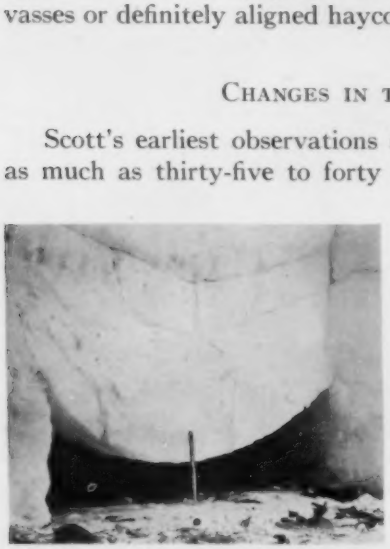


Fig. 24—Flowage of the shelf ice as seen in a small storage cave.

We found in places that the outline of the Bay of Whales had greatly changed since Amundsen's surveys. With the help of Ronne we were able rather definitely to locate Framheim, and so far as we can judge from Amundsen's astronomical observations compared with our own there has been no pronounced northward movement since his time. Cape Man's Head, one of the most distinctive features on the east side of the bay, looks very much as it did when photographed by Amundsen. Nevertheless, there is a considerable amount of movement in the shelf ice about the Bay of Whales; and the ice of the bay itself underwent profound changes even during our brief stay beside it. From the southern end of the Bay of Whales we noted the same two great zones of active crevasses observed by Amundsen. One trends southwest and the other southeast, and both could be

followed inland from thirty to forty miles. The ice of the Bay of Whales itself is subject to intense lateral thrusts. In places the strain has been relieved by the formation of great pressure ridges; in other parts of the bay and often between the pressure ridges themselves the ice has been squeezed into a great series of veritable anticlines and synclines. In the main part of the bay the axes of these folds are parallel to the axis of the bay. Whence come the great thrusts that have caused all this disturbance without noticeably affecting the shelf-ice boundaries on either side is still largely a mystery. A complete aerial survey was made of the bay, and perhaps when the mosaic is completed we shall be able to answer this question and further determine the relation of the major crevasse zones to the ice phenomena of the bay itself.

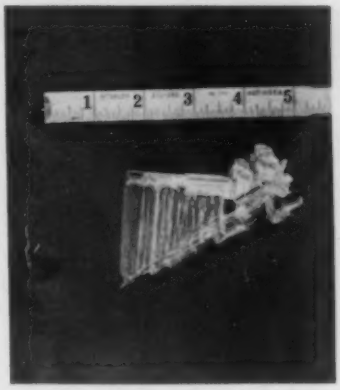


FIG. 25—Ice crystal. Crystals of this size are not uncommon.

In attempting to reach Little America during the summer of 1930 the *City of New York* was blown far to the westward, fetching up against the shelf ice within sight of Mt. Erebus; and thus in order to reach the Bay of Whales she had to sail along almost its entire front. Time was too short to make any but the most hasty surveys. These did not include accurate latitude measurements of the shelf-ice front to see whether it had advanced or receded. They did, however, show many changes in outline along the portion westward from Discovery Inlet. Where Scott had found indentations there were now none, and again new indentations had formed where there were none before.

It is of interest here to return to the observations made by the geological party. The very direction of the ice flow along the foot of the mountains mapped indicates a maximum outward push in the western portion of the shelf ice, to say nothing of course of the great amount of ice flowing out from Beardmore and the other outlet glaciers west of Liv. Furthermore, the crevasses between latitudes 81° and 82° indicate that the shelf ice is here held back by land or a submerged reef of some sort which definitely obstructs the direct northward flow of ice. Again, the great hill south of Little America further blocks a northward movement of the shelf ice; and finally Commander Byrd found crevasses in latitude 80° 45′ S., longitude 173° W., west of the crevassed region we crossed. These observations but further substantiate David's studies that from Discovery Inlet eastward the shelf-ice front has not undergone great changes in recent years.

Composition of the Shelf Ice

The presence of numerous crevasses about Little America as well as the exposed face of the shelf ice gave us abundant opportunity to study its composition. Everywhere above sea level it is made up of snow. The top few inches to three or four feet is made up of ordinary snow. The remainder down to sea level is composed of granular snow. Nowhere could we make out a systematic arrangement of layers of this granular snow. Sufficient melting to form crusts is rare, and there seems little or no way to distinguish between seasonal amounts of precipitation. The speed with which this granular snow accommodates itself by flowage was a surprise to all of us. Haines and Harrison, the meteorologists, made a snow house for storing their kites; and at a depth of about five feet below the surface level they dug caves horizontally into the walls to make additional storage room. Within four months the roofs of these small caves had sagged as much as six to eight inches across a span of four feet. All this happened under the severest temperature conditions of the year. The caves were made in the late fall, and the measurements were taken in the spring.

Particularly where the crevasses go down to the sea the rising moist air has left along the walls and pendant from the roofs an array of ice crystals prodigious in size and infinitely varied in form while always of the hexagonal system. It was common to find individual crystals from five to ten inches across.

PLANETABLING FROM THE AIR

AN APPROXIMATE METHOD OF PLOTTING FROM OBLIQUE AERIAL PHOTOGRAPHS

O. M. Miller

American Geographical Society's School of Surveying

THE method of oblique aerial surveying described in this paper[1] offers a means of making small-scale contour maps at a relatively low cost as compared with either ground survey or conventional air survey methods. Many sections of the earth's surface that are not in a state of settlement or economic development requiring large-scale maps are important from the standpoint of cartography and physiography. For instance most of the coastal regions of Mexico and Central and South America even along routes regularly traversed by the air transport lines are still unsurveyed except for the delineation of the coast line and the location of a few spot heights. A broad strip of these coastal areas could be mapped by the method proposed in sufficient detail for all present purposes, the necessary photographs being taken during the regular flights.

Aircraft, while rapidly becoming an essential part of exploration equipment, still are used for the most part for transportation and reconnaissance work by observation only. The Oxford University Arctic Expedition of 1924 made use of oblique aerial photographs in constructing the maps of the expedition.[2] It is also understood that the Survey of India has done extensive reconnaissance air surveying in mountainous regions. Nevertheless it has rarely happened that aerial photographs have been used for the construction of contoured maps on exploratory work. The reason for this seems to be that the money generally available for a reconnaissance survey does not allow for the cost of the immense amount of labor required for a thorough utilization of the wealth of detail provided by vertical or oblique photographs taken in the conventional way. Again, in order that the height data contained in the photographs may be utilized it has been generally considered necessary to provide extensive ground control, in which event it may be cheaper and more efficient for the purposes in view to make the hypsometric part of the survey altogether by ground survey methods.

[1] The idea of this paper was first developed in a memorandum prepared for Sir Hubert Wilkins by Mr. W. L. G. Joerg and the writer. A field procedure was suggested for use in the Antarctic which would enable photographs taken during an exploratory flight to be utilized as material for a map without adding unduly to the cost of the expedition.

[2] See *Geogr. Journ.*, Vol. 66, 1925, pp. 130–133.

In Canada much use has been made of oblique aerial photography for the mapping of flat areas, but photogrammetric surveys of areas of high relief in that country have been up to now confined to ground work where the photographs are taken from predetermined positions.[3] Use has also been made of oblique aerial photographs in the extensive survey just completed in Northern Rhodesia and described by Major Cochran-Patrick in the following article (pp. 213–220).

The method developed in this paper depends on the assumption that it is possible to determine the horizontal on the photograph by trial and error, provided the silhouette of the landscape against the sky is visible.[4] It enables the position of the air station in space and the tilt and direction of the camera axis at the time of exposure to be determined very quickly by graphical methods and by simple formulae depending on the fundamental principles of perspective. Once two or more air positions have been determined from the initial ground control the extending of the latter so that other air stations can be determined and other grounds points plotted is undertaken in very much the same way as a plane-table surveyor makes his map in the field. Hence the title of this paper. Accurate navigation of the airplane is not necessary, ground control is required only as a basis for scale, and the precision of the resulting map should be of an order comparable with a first-class plane-table survey.[5] As to the theory underlying the method the writer does not claim to have discovered new principles. The problem of graphical resection in space has been quite fully discussed by various writers.[6] The methods which they describe, however, seem to the writer to be too laborious for the purpose in view, namely the making of a small-scale reconnaissance map.

Theory of Approximate Resection in Space

In developing the method and formulae for finding the horizontal position of the air station, its height above the datum level and the orientation and tilt of the camera axis to the horizontal it is necessary to consider three reference planes. These are the plane of the photograph, the horizontal map plane, and the principal plane of the camera, which last is defined as the vertical plane containing the optical axis.

[3] F. H. Peters: Aerial Photography Applied to Maps, *Canadian Engineer*, Vol. 58, 1930, pp. 563–569.

[4] To avoid confusion in the reader's mind it should be stated that by horizontal is not meant the horizon but only any line parallel to the horizon.

[5] Without going into the technique of plotting, a general discussion of reconnaissance surveying by oblique aerial photographs is to be found in "Aerial Surveying by Rapid Methods" by B. M. Jones and J. C. Griffiths, Cambridge University Press, 1925. In this book, however, it is suggested that the accuracy of the plotted map will depend largely on the accuracy of the navigation of the airplane.

[6] L. N. F. I. King: Graphical Methods of Plotting from Air Photographs, Professional Papers of the British Air Survey Committee No. 1, London, 1925; H. S. L. Winterbotham: Photographic Surveying in "Photography as a Scientific Implement," London, 1924, pp. 349–400.

In order to simplify the explanation of the theory a system of notation for describing the various points and lines to be dealt with in the geometrical construction will now be stated.

As by convention the focal length of the camera is referred to as f. The ground control points are numbered 1, 2, 3 ..... (see Fig. 1). The horizontal distances on the map between the air station and points on the map will be referred to as the y distances, and the heights of points on the ground above datum level will be called the z heights.

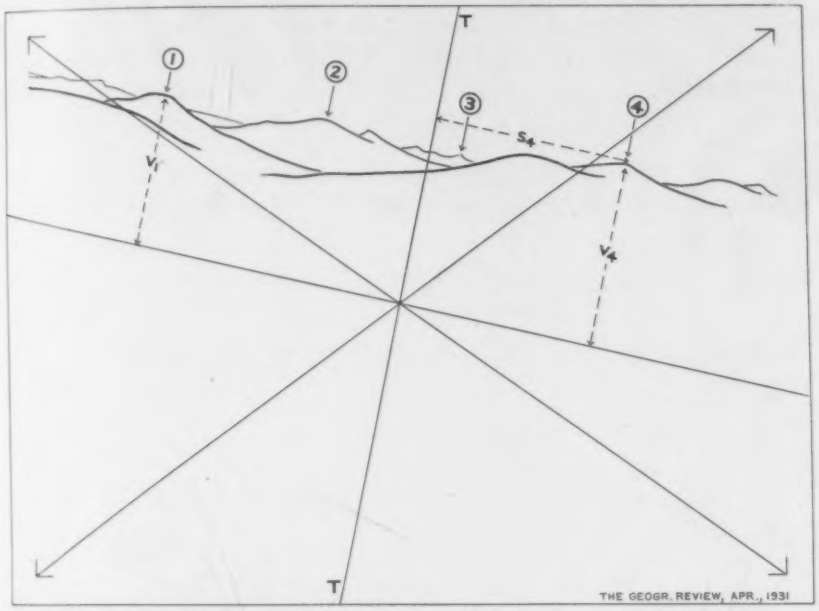


FIG. 1—In this figure TT is the trace of the principal plane on the photograph.

In the plane of the photograph (Fig. 1) the origin of the two-dimensional coördinate system will be the principal point, and one axis will be the trace on the photograph of the principal plane. This axis will be called the v axis, the other axis will be called the s axis. For example, the rectangular coördinates of the image of control point 3 on the photograph in respect to the principal point will be $\pm v_3$ and $\pm s_3$.

Let the vertical and horizontal angles subtended at the air position by the ray to a ground control point and the optical axis be a and b respectively.

Then $$\tan a = \frac{v}{f} \qquad \ldots\ldots\ldots \quad (1)$$

$$\tan b = \frac{s}{f} \qquad \ldots\ldots\ldots \quad (2)$$

In Figure 2, M and N are two ground points, S is the air station, and P_m and P_n are the plumb points of S in the horizontal planes containing M and N respectively.

In order to understand the figure it should be assumed that for purposes of comparison the vertical triangles SMP_m and SNP_n have been swung round the vertical axis SP into the principal plane.

Let D be the angle of tilt of the optical axis of the camera to the horizontal, and let H be the height of the air station above a ground control point,

then $$H = y \cot (90^\circ - D \pm a). \quad \ldots\ldots\ldots \quad (3)$$

The angle $(90^\circ - D \pm a)$ represents the tilt from the vertical of the visual ray from the air station to the control point. Let this angle be called E,

then $$\frac{\sin N}{\sin P} = \frac{y_1 \sin (a_1 \pm a_2)}{d \sin E_1},$$

but P equals 90° and sin P equals 1, hence the equation may be written

$$\sin E_1 \sin N = \frac{y_1}{d} \sin (a_1 \pm a_2);$$

but $$2 \sin E_1 \sin N = \cos (E_1 - N) - \cos (E_1 + N),$$

therefore

$$\cos (E_1 - N) = \frac{2y_1}{d} \sin (a_1 \pm a_2) + \cos (E_1 + N); \quad \ldots\ldots\ldots \quad (4)$$

and from the figure and as P equals 90°,

$$E_1 + N = 270^\circ - M - (a_1 \pm a_2); \quad \ldots\ldots\ldots \quad (5)$$

also $$\tan (180^\circ - M) = \frac{z_2 - z_1}{y_2 - y_1} \quad \ldots\ldots\ldots \quad (6)$$

and $$d^2 = (y_2 - y_1)^2 + (z_2 - z_1)^2. \quad \ldots\ldots\ldots \quad (7)$$

Practical Application of Method

It is possible to obtain from the photographs alone sufficient data to determine the relative positions of the air stations and the prominent features in the landscape; though the scale of the plotted positions will be unknown. The procedure for doing this will be discussed later. At present it will be assumed that at least three accurately located ground control points can be identified in each photograph and, if only three control points are used, that the position of the air station should not lie on or near the surface of the vertical cylinder containing the ground points. Furthermore, in determining the height of the air station and the tilt of the camera axis, the control points chosen

should not be even approximately the same distance from the air station if the difference in height between them is small, and vice versa.

The focal length of the camera, or more accurately the "principal distance," must be definitely known; and on the margins of each

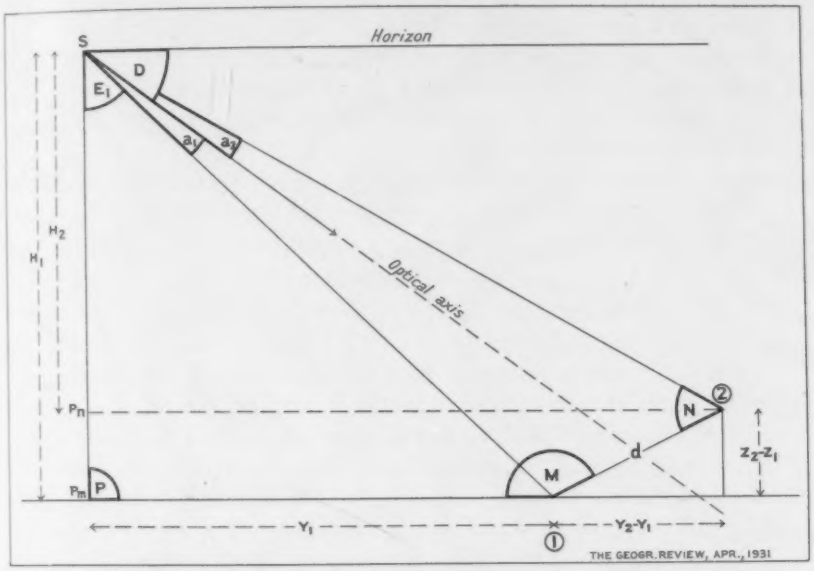


FIG. 2—The paper represents the principal plane of the camera.

photograph should appear fiducial marks whereby the principal point or optical center of the photograph may be determined.

By inspection of the features appearing in the photograph a line should be drawn through the principal point which, as far as can be judged, is parallel to the horizon line. There are always numerous indications on oblique aerial photographs, such as clouds, distant flat-topped mountains, etc., which will make it possible to do this with considerable accuracy. No one indication of the horizontal should be taken by itself, but only the accumulated evidence of all the indications on the photograph should be accepted. The line perpendicular to this horizontal line and also passing through the principal point (see Fig. 1) is the trace of the principal plane on the photograph.

The next step is to measure as accurately as possible the *S* perpendicular distances of the control points from the trace of the principal plane on the photograph. The ideal instrument for making these measurements would be a photogoniometer, but quite accurate results can be obtained with an ordinary pair of dividers if they are handled with care. On a sheet of tracing paper measure off a distance exactly equal to the focal length of the camera, and through one end of this

line draw another line at right angles to it. On this second line measure out the s distances from the center. Draw rays passing through these s points and the other end of the focal length. Adjust the tracing paper on the plotting sheet on which the ground control points have already been plotted so that the rays pass through their corresponding control points (see Fig. 3). Mark on the plotting sheet the air position obtained in this way and also the trace of the principal plane. This latter gives the horizontal direction of the camera axis at the time of exposure. On the photograph drop v perpendiculars from the control points, and measure these distances with care. Convert them into angular measurements a by formula 1.

Make a determination of the correction for curvature and refraction of each control point. In doing this the horizontal distance between the air station and the control point as measured on the plotting sheet should be used. Subtract these corrections from the known heights of the control points. In Figure 2, $(z_2 - z_1)$ is the difference in the apparent heights of control points 1 and 2 as seen from the air station.

Take two suitable control points and by means of formulae 3 to 7 inclusive make a determination of the height of the air station and the tilt of the optical axis to the horizontal. Check the correctness of the result by finding by ordinary trigonometrical methods the difference in height between the air station as determined and a third control point. If this check is not satisfactory, another horizontal must be assumed and the process repeated. By examination of the two results a third set of results can be interpolated, which in most cases will be sufficiently correct. Provided the images of the control points on the photograph are not too far apart in a vertical sense, small errors in the assumption of the horizontal will have very little effect on the horizontal position of the air station, and consequently it often happens that in making a second determination of height and tilt the same y distances may be employed as in the first determination. This saves much time; but as a warning it should be stated that considerable experience is required before one is in a position to judge as to whether such a short cut is justifiable.

The Fixing of Additional Points on the Map

In plotting new points it is necessary that the position of at least two air stations should be first determined and that such photographs as cover the same area should be exposed from widely different points of view (see Fig. 3). Points can then be located horizontally by the graphical intersection of rays from the air stations, utilizing the s distances in the manner already described.

The heights of the points in respect to the air stations are then determined trigonometrically as in plane-table work, the data being

the algebraic sum of the angles D and a and the measured distance on the map between the air station and the point. Consideration must be given to the effects of curvature and refraction.

A sufficient number of points are located on the map to provide control for sketching in topography and a means of extending the

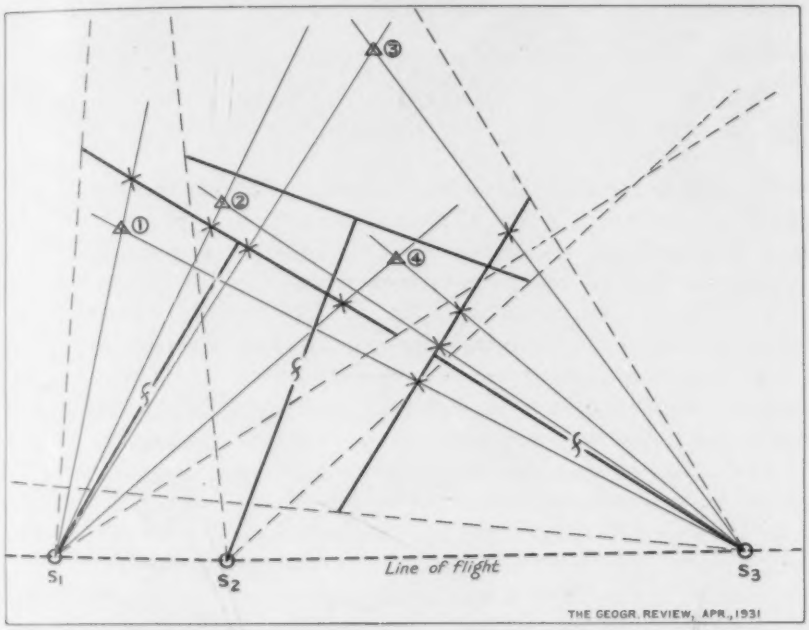


FIG. 3—The paper represents the plane of the map. The positions of S_1 and S_2 in respect to each other are suitable for the plotting of points. The relative positions of S_1 and S_2 are suitable for the stereoscopic examination of the terrain.

ground control to other photographs. The sketching is done as in plane-table work and is much improved if it is found possible to view pairs of photographs stereoscopically. Whereas the pairs of photographs used for obtaining control should have their camera axes pointing in widely different directions, in the case of pairs of photographs to be used for stereoscopic examination of the terrain their optical axes should be only slightly convergent or approximately parallel (see Fig. 3).

FIELD PROCEDURE

As air positions and ground points are located by resection and intersection methods, the conventional method of photographing the terrain in a series of overlapping photographs having their principal planes more or less parallel to each other is not suitable.

If it is desired to map on both sides of the line of flight the best procedure would be to photograph in all directions, swinging the camera

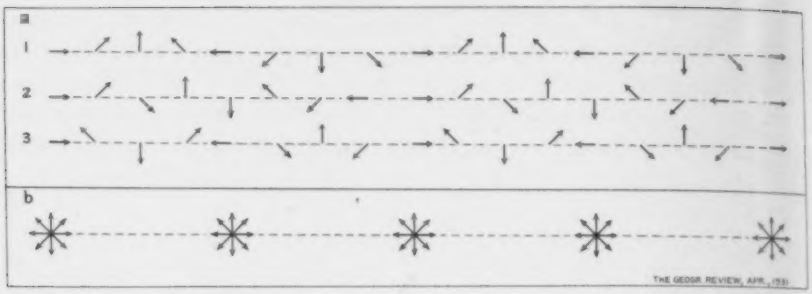


FIG. 4

round the horizon at suitable intervals. For instance, supposing the horizontal angular field of view of the camera to be about 60°, the horizon would be adequately covered in eight exposures. Three systematic ways of taking the exposures are shown in *a*, Figure 4. In the writer's opinion the best is No. 3. Photographs should also be taken, if possible, on the return flight, and this should be several miles apart from and parallel to the outgoing flight. It is not necessary that the flights should be straight: in photographing a coast line the flight would follow approximately the outline of the coast.

If for various reasons it is desirable to photograph only while flying in one direction, then at the beginning and end of the flight the plane should depart from the course somewhat in order that at least four photographs may be taken covering the same ground control.

Though sufficient data can be obtained by photographing with a single-lens camera in the manner suggested, the ideal instrument would be a multiple-lens camera covering the whole horizon. If such a camera is used the exposures need not be taken at such frequent intervals and the plotting operations would be greatly shortened. Figure 4, *b* indicates the advantage of such a camera.

The frequency of the exposures necessary is dependent on the height of flight, and this in turn is dependent on the desired scale of the map, the visibility, and the type of country being photographed. No hard-and-fast rules in respect to this are desirable, and the photographer in the field must come to a decision himself after taking all the circumstances into consideration.

The ideal ground control for this method of plotting from oblique aerial photographs would be a triangulation network covering the whole area. This of course is usually out of the question. However, satisfactory ground control would consist of precisely determined astronomical positions some fifty miles apart with the location of a few of the most prominent points in the immediate vicinity of the astronomical stations accurately determined by trigonometrical methods. The minimum ground control permissible would be, first, two astronomical stations well separated from each other and pref-

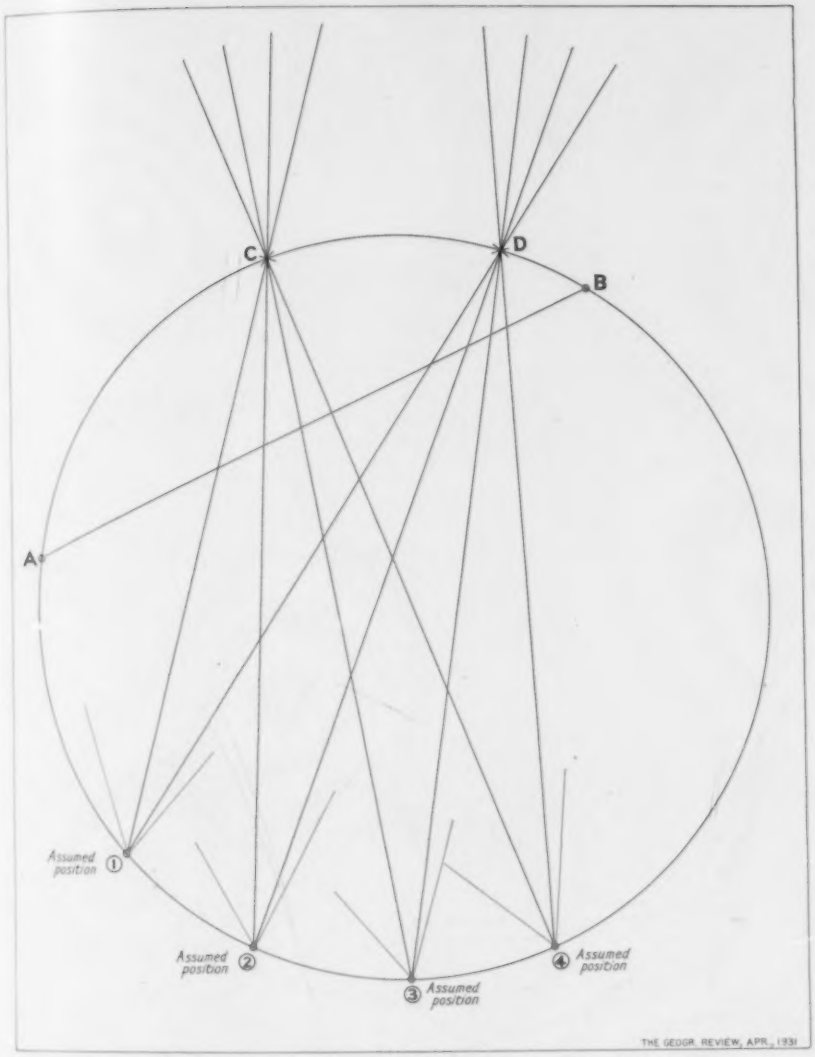


FIG. 5

erably at either end of the flight and, secondly, the difference in level between two easily identifiable points in one and the same photograph.

OBTAINING THE GEOMETRICAL PATTERN

When only the minimum of ground control is available or when the quality of the ground control is poor, it is necessary to determine the geometrical pattern of the landscape from the photographs themselves.

Disregarding the scale, we can always assume the positions of two points on the map; and the air position of any photograph on which

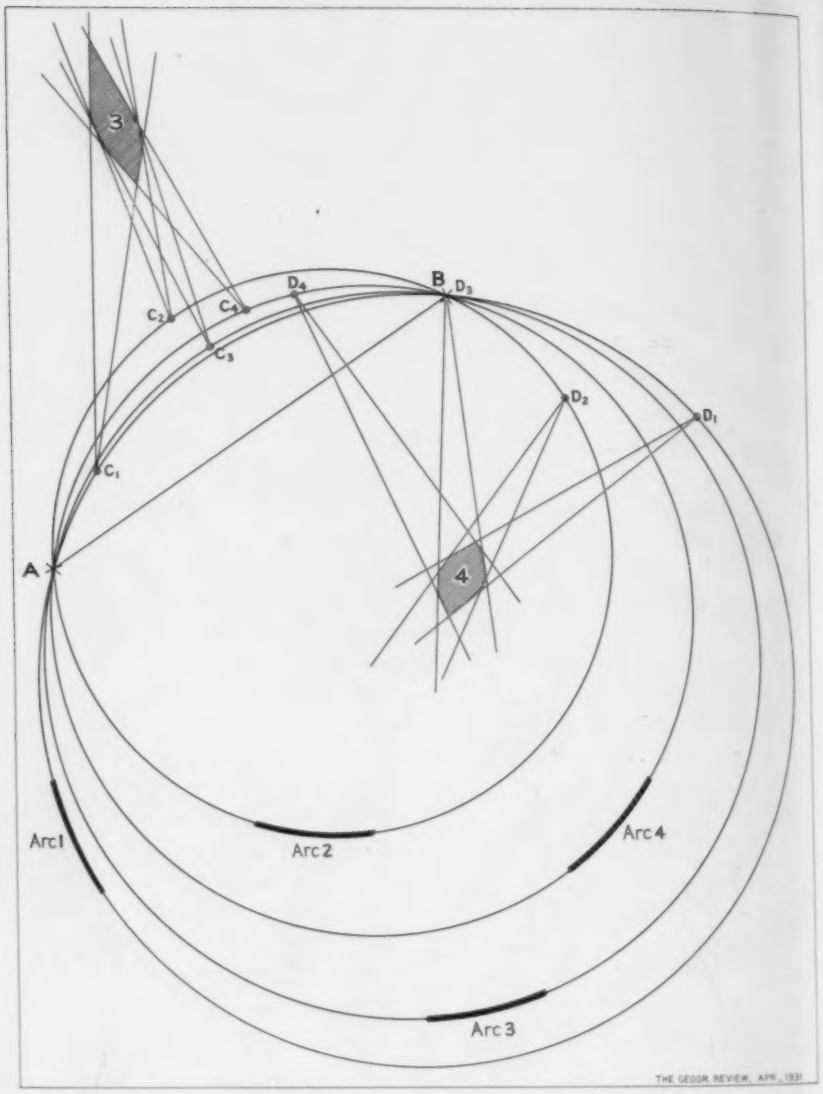


FIG. 6

these points appear can be located as being somewhere on a circle passing through these two points whose chord subtends an angle at the circumference equal to that determined from the photograph. If now two or more points appearing on the photographs are chosen, then we know that no matter where the position of the air station happens to be on the circle the ray to the third or fourth point will pass through a single point on the circumference of the circle. In Figure 5, *A* and *B* are the points we assume fixed. S_1 S_2 ..... are various possible positions of the air station on the circle. *C* and *D* are the points on

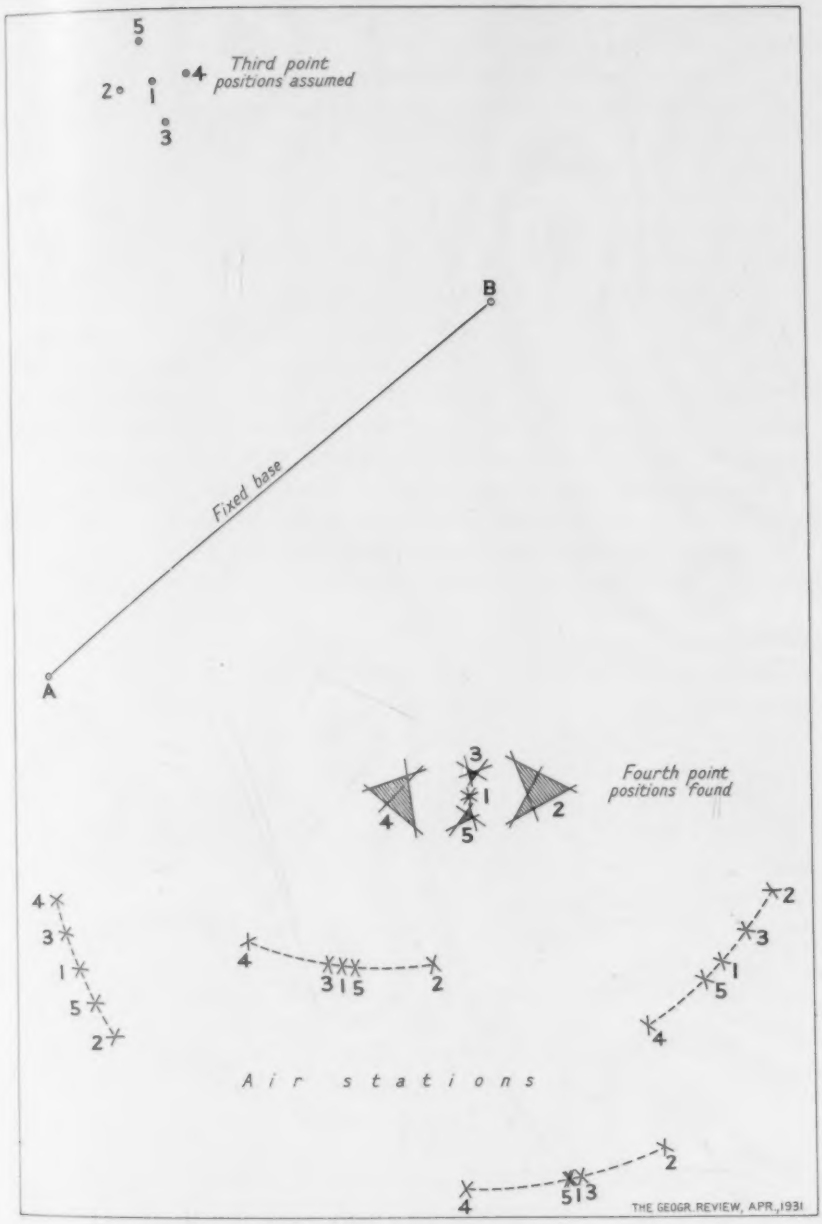


FIG. 7

the circle through which the rays from the air station to the third and fourth points must pass.

If then we take four photographs in each of which appear the four ground points, we can draw the position line circles for each of the air

stations in respect to points A and B and very readily determine the points C and D on each of the circles.

By inspection of the photographs the general relationship between them can then be determined sufficiently to limit the position of each air station to a comparatively small arc on its position line circle. In this way by drawing lines through the points C and D a general idea is obtained as to the relative positions of the third and fourth points in respect to A and B. This is illustrated by Figure 6. The procedure then is to assume a position for the third point and find first where the air stations lie on their respective position line circles and then to draw rays from these positions through their respective D points. If these four rays intersect in a point, then we know that the relative positions of the four air stations and four ground points are correct. By trial and error the correct solution is eventually found, though the work requires a certain amount of patience.

The writer has not yet attempted to develop any set rules as to the significance of the various polygons of error in the position of the fourth point when the assumed position of the third point is wrong, but Figure 7 shows the effect of these errors in a particular instance.

AERIAL RECONNAISSANCE MAPPING IN NORTHERN RHODESIA

Major C. K. Cochran-Patrick

Director of the Aircraft Operating Co., Ltd.

THE northern boundary of Northern Rhodesia abuts on the Katanga area of the Belgian Congo, well known for its richness in minerals. Of recent years large areas of copper ore have also been discovered in Northern Rhodesia. The rapid development following this discovery has naturally created a demand for accurate maps on which to base the alignment of new roads and subsequent railway lines to facilitate the extraction of the ores and their delivery to the coast. It was quite impossible for the local Survey Department to keep pace with the requirements, and therefore the Colonial Government entered into a contract for the reconnaissance mapping of a large portion of the territory by aerial photographic means.

The Aircraft Operating Company, Ltd., of London had an expedition working in Northern Rhodesia for the Rhodesian Congo Border Concession, Ltd., in 1927,[1] and they were accordingly approached on the subject of rapid reconnaissance surveys. A preliminary area of some 10,000 square miles was mapped on a scale of ¼ inch to the mile from the photographs that had been taken by the company for the mining corporation concerned, and these maps were so successful that a further contract was entered into for the survey of an additional area of 63,400 square miles. The photography for this survey was started at the beginning of May, 1930, and was completed in the short space of four months. Ground survey parties are still engaged in fixing by astronomical methods and wireless time signals the necessary control points on which to base the maps, and the actual mapping work is proceeding at the company's drawing offices in London. It is expected that the work will be completed by the end of July, 1931, some nineteen months after the signing of the contract.

Vertical and Oblique Photographs

It is generally known that two types of air photographs can be used for the preparation of maps. The first is the vertical photograph, taken with the camera pointing vertically downwards towards the earth and therefore giving an approximate plan view of that portion of the earth's surface directly beneath the airplane.

The second type is the oblique photograph, taken with the camera

[1] Aerial Survey in Northern Rhodesia, *Geogr. Rev.*, Vol. 19, 1929, pp. 508–509.

FIG. 1

FIG. 2

FIGS. 1 and 2—Reproductions on a greatly reduced scale (approximately 1 : 1,250,000) of maps of an area in Northern Rhodesia along the boundary with Katanga and immediately north of Broken Hill. Figure 1 is from the Aircraft Operating Company's aerial survey; Figure 2 is the same area from the official map of Northern Rhodesia on the scale 1 : 250,000 (a portion of Kashitu sheet, 1924). Note how the accuracy and detail are increased with the assistance of aerial photographs.

immediately north of Broken Hill. Figure 1 is from the Aircraft Operating Company's aerial survey; Figure 2 is the same area from the official map of Northern Rhodesia on the scale 1 : 250,000 (a portion of Kashitu sheet, 1924). Note how the accuracy and detail are increased with the assistance of aerial photographs.

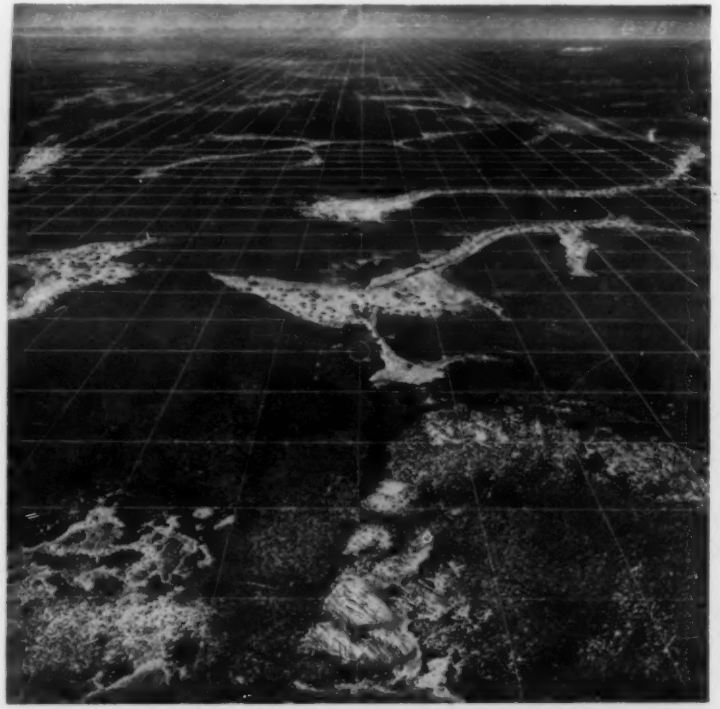


FIG. 3

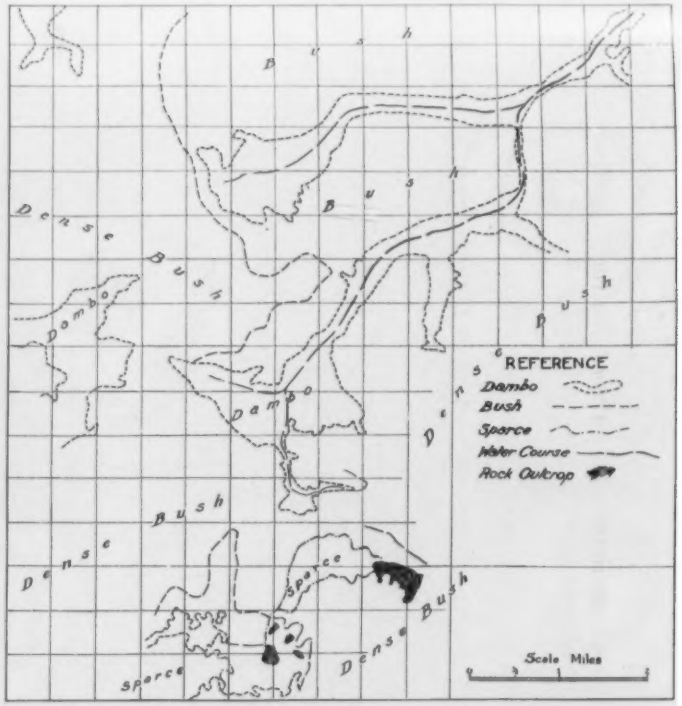


FIG. 4

FIGS. 3 and 4—A typical oblique photograph with perspective grid superimposed and a section of map prepared from the photograph

pointing at such an angle that the horizon appears in the top portion of the photograph. As this photograph shows the ground from a point quite near the airplane to the horizon, it is possible to map a much larger area from one of these photographs than from a single vertical

FIG. 5—A vertical photograph of typical Northern Rhodesian country. The land is covered with thick bush in which some trees reach a height of 20 to 30 feet. On the borders of the streams, which swell to swamps during the rains, there are as a rule open spaces, *dambos*, which during some nine months of the year are covered with long grass.

photograph, provided the mapping is to be done on a small scale without much detail. By the help of recently produced stereoscopic instruments and improved drawing-office methods, it is possible to join together a strip of consecutive vertical photographs with a high order of accuracy. On the other hand, the maps prepared from individual oblique photographs by the perspective grid method cannot be joined together accurately unless they are fitted between strips of more accurate work. In the surveys undertaken in Northern Rhodesia these limitations have been allowed for.

In order to provide a framework on which to place the maps prepared from oblique photographs, parallel lines of vertical photographs were first taken running due east and west at intervals of 300 miles. As soon as these first photographs had been developed they

FIG. 6—The bush fires which prevail during the latter months of the dry season in Northern Rhodesia prove a great hindrance to aerial survey.

were printed, and sets of prints were handed to ground-survey parties. These parties were supplied with prismatic astrolabes and wireless equipment. Their work was to march along the lines of vertical photographs, using them as maps. Every 30 miles the party formed a camp and by means of astronomical observations and wireless time signals fixed the exact latitude and longitude of a definite object appearing upon one of the photographs.

In this manner the map traverse prepared from the vertical photographs can be fixed into its position on the earth's surface; for, by arranging the check control points not more than 30 miles apart, the interval between is not sufficient to allow any errors in the travers-

ing of the photographs to appear when reduced to the scale of the map. There is thus available in the drawing office a succession of strip maps of country running in parallel lines across the area and fixed definitely and accurately in position.

FIG. 7—A high-altitude oblique of typical Northern Rhodesian country.

As soon as the vertical strips had been taken and the first prints handed to the survey parties further small prints were made and stuck together in strips. These were used by the pilots in the air in order to guide them in flying a series of parallel lines running north and south across the vertical strips and at intervals of about ten miles. During the flying of these lines oblique photographs were taken to the rear and to both sides.

The oblique photographs are converted into small map sections by the use of a perspective grid, and these map sections are joined together and fitted to the control lines of vertical photographs in such a way as to fill up the detail of the country between the control lines.

Comparison with Canadian Methods

The use of oblique photographs for mapping is well known, as it has been extensively employed in Canada during the last five years.[2] The methods of operation used by the Aircraft Operating Company

Fig. 8—A low-altitude oblique showing the junction of the Kafue and Lunga rivers, Northern Rhodesia.

for work in Africa are, however, considerably different in detail from the methods used in Canada. In Africa, for instance, the photographs are taken at a greater altitude, from at least 10,000 feet above the surface of the ground, so that a more vertical view is obtained and consequently a greater distance can be mapped without interference from high trees. Also the side shots are taken at 90° to the line of flight. This economizes in width of strip as the line of similar scale at the edge of the strip lies parallel to the center line of flight instead of having a jagged edge, as occurs when the side shots are taken at 45°

[2] Gerard H. Matthes: Oblique Aerial Surveying in Canada, *Geogr. Rev.*, Vol. 16, 1926, pp. 568–582.

to the line of flight. By treating right-side shots, center shots, and left-side shots as three separate units, instead of treating a sweep of left, center, and right shots as a unit, it is possible to use an automatically controlled camera taking photographs at regular intervals. This is done by so arranging the timing that a good overlap on the side shots can be obtained. If there is, for instance, an interval of three miles between shots to the right, this gives time to take a rear shot and a shot to the left side at intervals of one mile apiece. Photographs are then taken, rear, right, left, rear, right, left at regular intervals of a mile and joined up subsequently.

Use of the Maps

The earlier maps prepared from these photographs have been found to be excellent for development purposes. Owing to the nature of the country, which is gently rolling and has no serious hill features that may prove obstacles to roads, it has been found unnecessary to include contours. The drainage systems, which show up very clearly in the photographs, provide all the indication necessary for the most economic location of road lines. Information of the type of country, whether suitable for agriculture or not, can also be readily extracted; and general information sufficient to map the major geological features of the countryside can be gleaned by a careful study of the types of vegetation growing on the various geological beds.

NEW MOUNTAINS IN THE YUMA DESERT, ARIZONA*

Eldred D. Wilson

Arizona Bureau of Mines

DURING the winter of 1929–1930, in the course of geologic mapping incidental to a study of mineral deposits in southern Yuma County, Arizona, the writer visited certain mountain areas of the Yuma Desert region that are new in the sense of not having been shown on any known maps.

It may seem strange for any notable mountains to have remained so long unmapped and even locally unnamed in this historically colorful region. However, because of their comparative inaccessibility and lack of economic promise, combined with an extreme scarcity of water, these mountains are known only vaguely to a few persons. The southernmost mile of their length might well have been shown on the Boundary Survey maps, which here cover a width north of the international boundary of about two and a half miles. To understand why the early surveyors neglected to map some of the clearly visible features lying towards the outer edge of their alloted strip, one needs but to read of the difficulties that confronted them in this area.[1]

Later maps have perpetuated this omission, because no one engaged in systematic mapping ever traversed this area. Moreover, a reconnaissance observer looking southeastward into this area from a distance can easily mistake these mountain features for the masses that lie farther east and are indicated on current maps.

Aridity and Inaccessibility of the Desert

The Yuma Desert comprising the southwestern corner of Arizona is twelve miles wide on the north and extends more than forty miles along the international boundary. Its eastern margin is nearly forty miles long in Arizona and reaches for a like distance into Mexico to the Gulf of California.[2] Its outstanding characteristics are aridity—less than four inches mean annual rainfall, mostly torrential,—and

*Published with permission of the Director of the Arizona Bureau of Mines, University of Arizona.

[1] Report of the Boundary Commission upon the Survey and Re-marking of the Boundary between the United States and Mexico West of the Rio Grande, 1891 to 1896, Washington, 1898, Part II, pp. 119–120.

[2] Kirk Bryan: The Papago Country, Arizona: A Geographic, Geologic, and Hydrologic Reconnaissance, with a Guide to Desert Watering Places, *U. S. Geol. Survey Water-Supply Paper 499*, Washington, 1925, pp. 199–200.

summer heat—maxima of over 120° F. Water is available at only a few places in the mountains. Near the old Fortuna mine, in the western foothills of the Gila Mountains about fifteen miles south of the Gila River, are a few open prospect shafts which catch rain water. About a mile and a quarter to the northeast, in a canyon rather difficult of access, is a small spring. The mountains contain a few stream potholes that serve as natural rock tanks, but they are too small or too difficult of access for general use. Tinajas Altas (High Tanks), a noted and generally dependable series of natural rock tanks, is on the east, or Lechuguilla, side of the Tinajas Altas Mountains.

The Yuma Desert is without a permanent population. The scant Papago Indian population of earlier times perished of an epidemic or moved out eighty years ago,[3] and no other Indians have succeeded them. The ever-hopeful prospector, however, has continued during the cooler seasons to explore this region for precious minerals or for legendary buried treasure. As a result, the rich La Fortuna gold deposit came to light in 1895 and gave local employment to several hundred persons for about five years. For some time afterwards its caretaker was the sole permanent inhabitant not only of the Yuma Desert but also of a region extending ninety miles eastward and including in Arizona alone some 4000 square miles, or nearly the area of the state of Connecticut. This caretaker has, however, long since departed, so that the very few people now within this area are transients—prospectors, border patrolmen, unlawful hunters of mountain sheep, or others whose business is of questionable character.

One worn trail, a fork of the famous old Camino del Diablo,[4] is the only road traversing the area. It branches southeastward from the Yuma-Gila Bend highway at a point about sixteen miles from Yuma and extends near the eastern margin of the plain for eleven miles to the Fortuna mine. From there it continues very dimly for about thirty miles, passes over a low divide in the Tinajas Altas Mountains, and joins the north fork, whence the Camino del Diablo runs near the international boundary for many miles. This road, located by the early Spanish padres, was, during the fifties of the past century, the route of numerous California-bound gold seekers, who believed it safer and quicker than the usual route along the Gila; though for hundreds of them, inadequately equipped or too weak, it led but to desert graves.

At the present time the fork between the Fortuna mine and Tinajas Altas may have no vehicular traffic for months at a time, as it is rather difficult for automobiles and hazardous for the inexperienced. The motorist may have no thirsty animals to water but,

[3] Carl Lumholtz: New Trails in Mexico, New York, 1912, pp. 329–332.

[4] See Godfrey Sykes: The Camino del Diablo: With Notes on a Journey in 1925, *Geogr. Rev.*, Vol. 17, 1927, pp. 62–74.

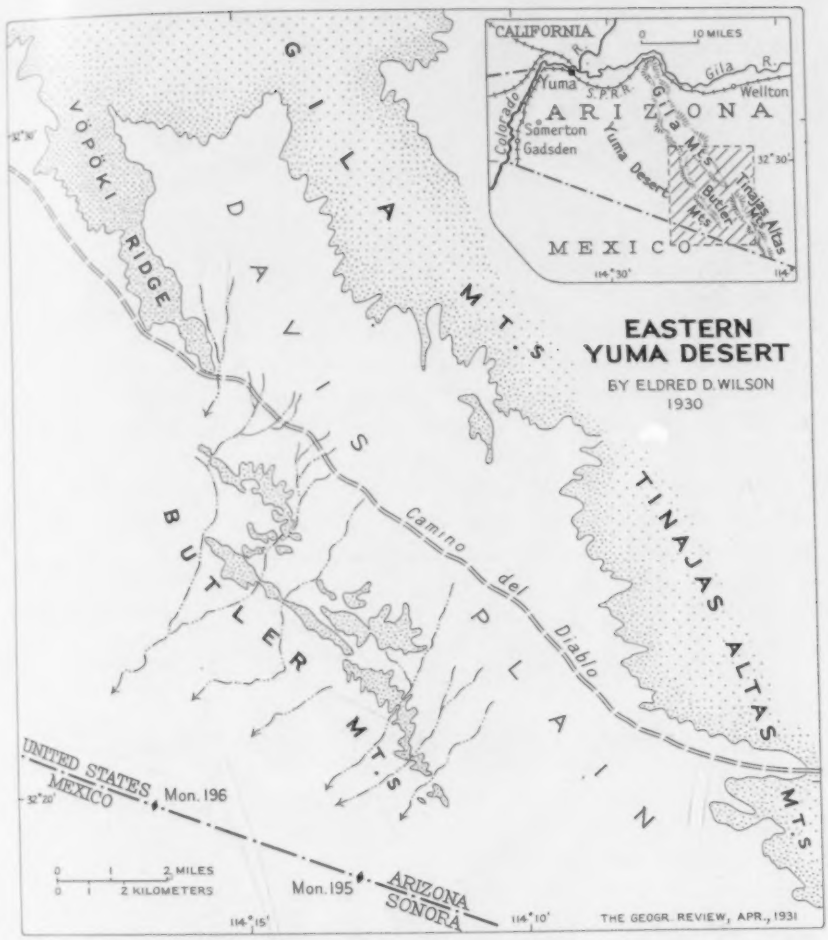


FIG. 1—Map of the eastern part of the Yuma Desert (compare inset) showing the newly mapped features—the Vöpöki Ridge and the Butler Mountains. Scale of map slightly over 1 : 200,000.

because of heavy sand and steep-sided arroyos, cannot depend upon averaging more than six miles an hour here.

THE MOUNTAINS OF THE DESERT

The distribution of mountain areas in the Yuma Desert is indicated on the accompanying map (Fig. 1). The mountains are dissected fault blocks of granitic and schistose rocks with much sheeting, fissuring, and jointing in longitudinal and transverse directions. In contour they are narrow and defined by generally linear, though serrated, boundaries. Rugged slopes, which are inclined from 35° to nearly 90° and culminate in sawlike crests, are typical of each mountain mass regardless of its size. These characteristically steep

slopes are the result of angular spalling operating with great facility under the extreme aridity.[5] So little vegetation grows on the mountains that they appear bare. In summer the sun daily heats the exposed rock surfaces to temperatures of 150° F. or more, while the night cools them fully 75°. Likewise the summer afternoon rains and subsequent evaporation cool all rock surfaces, but in a much shorter time. Even during winter the daily heating and cooling of all exposed surfaces continue to a notable degree.

Spalling keeps sufficiently ahead of the corrasive work of the ephemeral streams to produce, on a given type of rock, slopes whose declivities are nearly even and constant.[6] Dissection of the slopes (Fig. 6) depends upon the ease of erosion along zones of structural weakness, while steepness of slope and sharpness of crest in general are directly proportional to coarseness of grain, hardness, and scarcity of fissures.

Pediments, which in places extend with low declivity for short distances from the mountain bases and disappear beneath the margins of the detrital plains, are the rock floors to which effective spalling extends.[7]

The Vöpöki Ridge of the Gila Mountains

Bryan has described the eastern slope of the Gila Mountains and their western slope as far south as the Fortuna mine; and the U. S. Geological Survey has mapped the northernmost eighteen miles, that is to latitude 32° 30′ (Fortuna and Wellton quadrangles). At this point the Gila Range has a width of about six miles; but its remaining length is abruptly separated, by a plain nearly three miles wide, into two parallel ridges. The eastern, or larger, of these two ridges is seven miles long, from one to three miles wide, and in many places more than 2000 feet above sea level.

The western ridge is nearly six miles long and from one-half to two miles wide but narrows to a thin point at its southern extremity. Its jagged crest reaches about 2000 feet above sea level at the north but gradually declines southward. For this hitherto unmapped southwestern fifth of the Gila Mountains the name "Vöpöki Ridge" is proposed, in allusion to its serrated crest, which resembles the Papago symbol for lightning.

The Butler Mountains

The eastern branch of the Gila Mountains is continued by the Tinajas Altas Mountains for twelve miles to the international

[5] Compare Bryan, *op. cit.*, pp. 79–101.

[6] See A. C. Lawson: The Epigene Profiles of the Desert, *Univ. of California Publs. in Geol.*, Vol. 9, Berkeley, 1915–1916, pp. 29–48.

[7] For a thorough discussion of this subject see W. M. Davis: Rock Floors in Arid and in Humid Climates, *Journ. of Geol.*, Vol. 38, 1930, pp. 1–27 and 136–158.

FIG. 2

FIG. 3

FIG. 4

FIG. 2—Looking eastward at part of the Vöpöki Ridge.
FIG. 3—Looking southeastward at the northern part of the Butler Mountains.
FIG. 4—Southern end of Butler Mountains, looking southeastward.

boundary and for several miles beyond. Starting a mile and a quarter south of the southern extremity of Vöpöki Ridge and extending south 35° east to within a mile and a half northeast of international boundary monument 195 is the notable range of mountains mentioned at the beginning of this article as being new in the sense of not being shown on any current maps. In consideration of the encouragement given by Dean G. M. Butler, of the University of Arizona, to research in Arizona geology and geography, the writer proposes the name "Butler Mountains" for this range.

The Butler Mountains, as here defined, have a length of slightly more than seven miles, a maximum breadth of a mile and a half, and a maximum height of about 1300 feet above sea level. In several places narrow reaches of alluvium or of dune sand (Fig. 5) interrupt their continuity of length and breadth; and the range as a whole thus appears to be partly buried in detrital outwash which, derived from the higher Gila and Tinajas Altas Mountains, has filled the intervening structural trough to the level of these notches.

The range is composed of medium-grained, gray granite, which weathers brownish-gray. A few aplitic dikes and quartz veins are present, but the only mineralization noted was slight copper stain in some of the quartz veins. Minor faulting and pronounced sheeting are the only structural features apparent. The sheeting has several directions of trend, but the most noticeable is parallel to the axis of the range and dips steeply eastward, while a slightly weaker system runs at right angles to it and dips steeply southward. In spite of this sheeting the slopes of these mountains (Fig. 4) generally exceed 35°. Rock floors (Fig. 5) are visible in a few places, both at spur bases and in entrants, but their exposures are closely limited by overlapping outwash or dunes. No evidence of the recent, cliff-forming uplift described by Bryan for the east front of the Tinajas Altas[8] is apparent here. The Butler Mountains may represent a stage of erosion not far in advance of that which obtained in the Tinajas Altas Mountains before their cliff-forming uplift.

Davis Plain

A few special features of the neighboring intermont areas are of interest in connection with the foregoing descriptions.

Dr. W. M. Davis has pointed out[9] the suitability of the term "plain" for the intermont, detrital-floored troughs that, throughout the Southwest, have long been called "valleys." As the area occupying the entrant east of Vöpöki Ridge and extending southeastward

[8] Bryan, *op. cit.*, p. 76.

[9] W. M. Davis: Channels, Valleys and Intermont Detrital Plains, *Science*, Vol. 66 (N. S.), 1927, pp. 272–274; also Physiographic Contrasts, East and West, *Scientific Monthly*, Vol. 30, 1930, pp. 394–415 and 500–519.

FIG. 5

FIG. 6

FIG. 7

FIG. 5—Looking westward at dune sand flanking a ridge of the Butler Mountains.
FIG. 6—Canyon in middle part of Butler Mountains.
FIG. 7—Peaks of a granitic ridge surrounded by dune sand. Looking southeastward, from boundary monument 198, across the international boundary.

for about fourteen miles between the Butler and Tinajas Altas ranges is representative of this type of plain, the name "Davis Plain" is proposed for it.

The plains in this region are mainly in a stage of aggradation rather than degradation, because the ephemeral streams, although sometimes torrential, are unable to carry away the loads of detritus allotted to them by the overproducing agencies of mountain erosion. From the same cause all channels are subject to clogging, so that the streams finally spread their braided network over the whole plain (Fig. 3). This clogging is augmented by profuse growths of desert vegetation along the washes, in contrast to the rather thin growths between.

Wind-blown sand, which mantles most of the Yuma Desert plains, also interrupts the drainage. It forms notable dunes along the flanks of the Butler Mountains and southwest thereof. Some ten miles southwest of the Butler Mountains these dunes form a belt more than three miles wide that crosses the international boundary and surrounds the peaks of the buried granitic ridge upon which boundary monument 198 stands (Fig. 7). As exposed, this ridge is about a quarter of a mile long by an eighth of a mile wide in Arizona and extends south 43° east for about four miles into Mexico. The dunes are known to continue, over a wider area, to the Gulf of California.

Although several ephemeral streams from Davis Plain cut through and north of the Butler Mountains, they are unable to carry all of their load, and in consequence the northern portion of Davis Plain stands aggraded some 500 feet higher than does the plain on the west side of Vöpöki Ridge.

RAINFALL INVESTIGATIONS IN ARIZONA AND SONORA BY MEANS OF LONG-PERIOD RAIN GAUGES

Godfrey Sykes

Desert Laboratory, Tucson, Arizona

ONE of the most typical and pronounced arid areas in North America extends through southwestern Arizona, southeastern California, and northwestern Sonora, embracing also both shores of the Gulf of California almost to Cape San Lucas. Precipitation varies from an annual average of about 10 inches in the more elevated plateau regions to less than 2 inches at sea level. Isolated mountain ranges may receive as much as 40 inches upon their summits but without affecting the general aridity of the region.

Seasonal Concentration of Precipitation

Mean annual rainfall figures signify very little in a land in which periods of a year or more may pass without any precipitation whatever or in which, on the other hand, the computed annual mean may be approached or even passed in a single storm. The continued existence of even xerophilous vegetation in such a region depends upon the manner of the rainfall and the period or periods of the year at which it commonly occurs. One may assume, for instance, an annual mean of 10 or 12 inches, such as occurs in and around Tucson, Ariz., and consider the effect of various possible manners of its distribution. The existing distribution in this district by seasons is approximately according to the following percentages: winter, comprising December, January, February, and March, 35; spring, April, May, and June, 10; summer, July, August, and September, 45; autumn, October and November, 10.

Concentration into periods is in reality even more pronounced than is indicated in the summary by seasons, for during either the winter or summer rains most of the downpour is frequently grouped into a few heavy storms. The winter maximum is less strongly marked along the shores of the Gulf of California, but the distribution as outlined above is substantially correct for southern Arizona and northern Sonora.

The total evaporation for the year, as measured from an open water surface, may be as much as 100 inches. Obviously the massing of precipitation into seasons or periods affords the only system whereby

such a scanty annual amount becomes sufficient for the support of life in a region of frequent high temperatures and prevailing low humidity.

In planning the work of obtaining a general outline of rainfall conditions over as large a portion as possible of this extensive and previously unexamined region it was decided to concentrate upon seasonal totals rather than upon individual storm periods and to use a type of gauge that would give an approximately correct reading even if visited only at long intervals.

FIG. 1—Desert rain gauge after examination of contents in graduating jar (410 c.c. representing 3.66 inches of rain). Note the film of oil on the surface of the water.

THE DESERT RAIN GAUGE

Self-recording gauges of the various mechanical and electrical types were deemed to be unsuitable for an extended investigation of this description; first, as being too elaborate and expensive for a reconnaissance; and secondly, as being too liable to derangement under the field conditions.

It had been found that a simple container, connected by a short vertical tube with the standard form of measuring bowl, would give consistent and reliable readings if a small quantity of non-oxidizable oil, of low specific gravity, had been placed in the instrument at the time of installation. The oil film successfully protects the surface of the contained water from evaporation, even over long periods and in desert conditions of high temperatures and low humidity.

A gauging instrument was therefore designed embodying the principle of the protective oil film and sufficiently simple and substantial to stand up under field conditions. It has proved in practice to be quite reliable and sufficiently accurate for all practical purposes.

In its present form it consists of a truncated conical vessel about 9½ inches in height and the same diameter at the base, made of a good weight of sheet copper with folded and well soldered seams. It is surmounted by a vertical-sided but conical-bottomed measuring bowl, three inches in diameter, fastened to the upper end of a short

connecting tube which passes, through a removable screw cap, well down into the body of the container. A short spout is fitted at the angle of the frustrum-shaped body.

Copper is used in construction, as it is more durable than sheet iron or tin plate; the conical form was adopted because it is less easily dug up and displaced by coyotes and other thirsty and inquisitive animals; the short stem raises the measuring bowl a few inches above the ground surface when the instrument is buried, and the small spout facilitates emptying and measuring the contents.

It has been found in practice that about one hundred cubic centimeters of light mineral oil will fully protect the surface of the contained water against evaporation for a period of a year or more even under the trying conditions of desert sunshine.

A gauging instrument thus constructed will contain an amount (4500 cu. centimeters) corresponding to 40 inches of rainfall. This has been found to be more than ample capacity for even mountain-top readings, upon the basis of the usual six-month periods.

A minor but quite important point which has been discovered in practice is that it is necessary to paint the outside of the instrument and also the inside of the bowl a dull drab color and then dust the moist paint with fine sand, in order to make the apparatus less conspicuous to chance passers-by. A bright metallic object can be seen for a long distance in the dazzling sunshine and at once attracts attention and courts investigation.

Since this principle of camouflaging has been adopted very few of the instruments have been interfered with except in one case where a nearly completed six-month record was lost through the misplaced zeal of two ardent prohibition agents, who, finding an unknown object made of copper, assumed that it must be a new form of still. Another was twice very cleverly undermined and buried by a badger, who apparently objected to having it close to his residence.

Some of the instruments have now been in use for more than five years, and it has been found that with an occasional rinsing out to remove dead insects, wind-deposited sediment, and other foreign matter they continue to give every satisfaction. Twenty-four stations are being maintained at the present time; and, at several of these, seasonal temperature records are also taken.

Distribution of the Stations and Some Observations

The general plan of this meteorological cross-sectioning of the Arizona-Sonora region is to maintain two principal lines of gauges, extending as a large V from Tucson. One line is carried in a southwesterly direction to the shore of the Gulf of California at Puerto Libertad, with sundry ramifications up and down the coast, and the

other follows roughly along the international boundary in a west-northwest direction to the head of the Colorado delta. Other gauges are kept near to Tucson and in the domain of the Desert Laboratory. These are used chiefly for purposes of comparison. Several are placed in the surrounding mountain regions in order to furnish data

FIG. 2—Map of southern Arizona and northern Sonora to show location of desert rain gauges. The names of the stations have reference to some near-by feature as means of identification. Scale of map approximately 1 : 4,000,000.

concerning mountain precipitation, and three supplementary ones are at present installed temporarily at different points in the Colorado delta.

The investigation has been growing and its scope gradually extending from a tentative plan outlined about six years ago; and, although it is not yet possible to present any very definite picture of the climatic conditions of the region as a whole, certain facts as to distribution and the occurrence of torrential storms seem to be discernible in the accumulating series of readings. At some of the stations the seasonal variations are very strongly marked, as, for instance, at Fifty Mile Pass in Sonora, where a sequence of readings at approximately six-month intervals appears as follows: 10.06, 0.95, 15.62, 0.6, 7.5, 3.0, 6.8, 0.76, 8.5, 0.0, 7.76, showing the comparatively heavy summer

precipitation as contrasted with the extremely low winter rainfall and, for this region, a fairly uniform annual total.

At Kino Point, some 55 miles to the southwest, where the annual average is probably about 2.5 inches, simultaneous readings for the first eight periods were as follows: 10.00, 0.26, 0.73, 2.64, 0.90, 0.75, 2.85, 1.11. Here the seasonal alternation is lost, and the noticeable features in the series are the three irregularly placed periods in which precipitation of more than the assumed yearly average occurred. It was afterwards ascertained from the fishermen at Puerto Libertad that upon each of these occasions the rain had fallen in a single storm period.

At Tule Tanks, on the old Camino del Diablo, successive readings have been 1.15, 6.50, 1.26, 0.00, 0.70, 0.00; and here also the six-and-a-half-inch record was identified as having occurred in a single storm period in October, which is generally considered to be one of the dry months in the year. It will be noticed that at this typical desert location less than two inches of rain fell in the period of two years that followed this great downpour.

So far there is no tangible evidence of any conditions approaching a climatic cycle or pulsation; but, on the other hand, features of surface relief, even apart from the question of altitude, seem to be determining factors in inducing or deterring precipitation. It would probably be well, in order to obtain a complete analysis of climatic conditions over a sparsely settled region such as this, to place gauges at regular intervals over the entire area for obtaining data as to general distribution and then to supplement this network later by specially placed instruments at various strategic points. Color, texture, porosity, slope, and aspect of the bare desert soil are all undoubtedly important factors, although many fundamental facts regarding their influence over superheated areas such as the one under discussion are at present surmised rather than fully understood.

VICKSBURG

A STUDY IN URBAN GEOGRAPHY

Preston E. James

University of Michigan

THE personality of Vicksburg is well expressed in the contrast between two of the town's buildings which stand not three blocks apart on the slopes of the valley bluff overlooking the broad flood plain of the Mississippi. One of these is the old courthouse, which has watched over the varying fortunes of the town since the days before the Civil War and which is representative of a host of traditions dating back to the period when river towns could look with disdain on their inland neighbors. The other building is the new twelve-story hotel, Vicksburg's skyscraper, looking oddly out of place among the architectural types of the last century and representing a spirit of rejuvenation in the community life and the beginning of a renovation of the urban scene.

A River Town

The attachment of a nucleus of population to some site in the vicinity of Vicksburg seems to have come, almost inevitably, from the advantages of the situation. As the Mississippi River winds southward from Memphis, it leaves its eastern valley bluff to follow a course through the middle of its fertile flood plain. After more than 150 miles, the great river again impinges upon the eastern bluff. South of this point the meanders approach but do not touch the bluff for another 100 miles to the vicinity of Natchez, where two swings of the river reach the flood plain margin. The immediate site of Vicksburg is one of considerable relief, with a number of steep slopes. The valley bluff at this point rises about 140 feet above the flood plain, but, unlike the bluff at Natchez, it is not too steep for building. It has been cut in the deep accumulation of loess which borders most of the lower Mississippi flood plain and which makes up the material of most of the site of Vicksburg. Back of the valley bluff small tributary streams in dendritic pattern have dissected the loess into early mature ravines and ridges, with a relief of from 60 to 100 feet. As a result of the peculiar quality of loess which permits it to stand in steep slopes, the valley sides are characteristically steep, and the ridges relatively narrow. The valley bottoms are flat and in places

swampy. Two streams, or bayous, Glass Bayou and Stouts Bayou, trending from northeast to southwest drain the site of Vicksburg. Where the ridge which separates Glass Bayou from Stouts Bayou reaches the top of the valley bluff it broadens out into a fairly extensive area of relatively level land (Fig. 6). This favorable surface, located

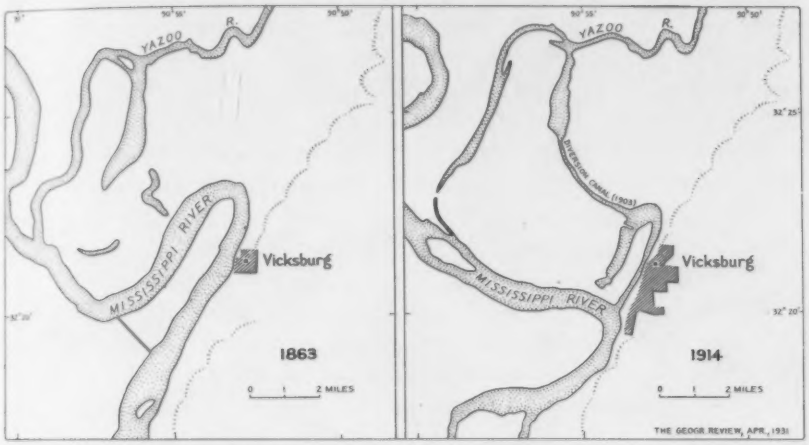


FIG. 1—The Mississippi and Yazoo rivers in 1863 and in 1914.

at the end of a ridge which gives easy access to the east, was occupied by a part of the original nucleus of the town.

While Vicksburg was originally located on the immediate banks of the Mississippi, such is not the case today. During a flood in 1876 (April 26) the river suddenly broke through the narrow neck of land inside its meander and left Vicksburg high and dry. For a number of years the town could not be reached by boat, but in 1903 government engineers again brought navigable water to its landing place by diverting the channel of the Yazoo River.

THE FOUNDATION OF VICKSBURG

Urban patterns come into being in various ways; but once established it is only rarely that they can be fundamentally changed.[1] Each part of a city reflects to a certain degree the period of its development, not only in the architecture of its buildings but also in its pattern of arrangement. In Vicksburg, for example, the rectangular pattern of the northern part of the city had its origin in a very different period from the confused array of patterns in the southern part.

Early use of sites in the vicinity of Vicksburg for the establishment of forts by the French and Spanish was not accompanied by any

[1] See Rudolf Martiny: Die Grundrissgestaltung der deutschen Siedlungen, *Petermanns Mitt. Ergänzungsheft No. 197*, 1928; and J. B. Leighly: The Towns of Mälardalen in Sweden, *Univ. of Calif. Publs. in Geogr.*, Vol. 3, 1928, pp. 1–134.

extensive settlement. During the closing years of the eighteenth century, however, while the ownership of this territory was still in dispute between Spain, England, and the United States, many settlement schemes were laid out, at least on paper.[2] Among the paper claims on the present site of Vicksburg was one by Andrew Glass, which was confirmed in 1803 when the area came definitely under the control of the United States. This was a rectangular tract oriented approximately parallel to the course of the river, which at that time ran about 25° west of south. The land grant was laid out 18° east of true north. This orientation placed it obliquely on the more permanent valley bluff, the presence of which was apparently disregarded. This tract of land later came into the possession of Mr. Newet Vick, whose plantation lay several miles to the northeast and who made use of the Glass tract as a location for his slave quarters.

The idea of establishing a town apparently originated with Mr. Vick. Before his death in 1819 he had made plans for the platting of his river property, and in his will he directed his heirs to carry out the project. In 1824 the Glass tract was marked off, and Vicksburg was established. A rectangular pattern, conforming to the outlines of the original land grant, was adopted, which made possible the sale of lots of uniform size and shape—a highly practical consideration. The blocks were two acres in area, separated by streets of 66 feet, or one chain, in width. However, two streets that intersect at the site of the courthouse were made 100 feet in width; and the road that approaches Vicksburg from the northeast, from Vick's old plantation, was allowed to interrupt the rectangular pattern to follow the trend of the ridge. The area between the westernmost street and the river was set aside as a common for use as a community landing place.

The application of this pattern to the site has had some interesting results. It misses the trend of the ridges, and as a result it is difficult to travel through the town without either making sharp ascents and descents or else a series of right-angle turns. The two wider streets that meet at the courthouse present an interesting anomaly, for they have never been used for commercial purposes and today stand in strange contrast to the narrow congested thoroughfare that runs through the commercial core.

Vicksburg at the Close of the Civil War

The period of growth along the lines of this pattern came to an end with the Civil War. General Grant's engineers have left valuable evidence regarding the extent of Vicksburg in 1863 in the detailed map drawn by them after the siege. This map shows that while the eastern margin of the original town had never developed, there were

[2] A. P. Whitaker: The Spanish American Frontier 1783–1795, New York, 1927; and R. Lowry and W. H. McCardle: A History of Mississippi . . . . , Jackson, 1891.

FIG. 2

FIG. 3

FIG. 4

FIG. 2—The Courthouse on the side of the valley bluff at Vicksburg.
FIG. 3—Looking north towards the bend of the Yazoo.
FIG. 4—Looking southeast across the commercial core to the wholesale district and the industrial plants along the water front.

a few new streets, also on a rectangular pattern, which had been added to the northeast and the southwest, and that the beginnings of a new subdivision had been made in the valley bottom some distance to the east. There was a small commercial section along the streets north and east of the courthouse, but the chief commercial core was located, as now, along Washington Street, the only connected route of travel north and south through the town. The commercial core was surrounded by a ring of residences, with superior residences localized in two places.

A second period of development began at the close of the Civil War. In 1860 the town contained some 4500 people, with whites predominating nearly three to one. In 1870 there were about 12,500 people, with 55 per cent of them negroes. These figures tell a story of radical change. The well ordered life of an *ante bellum* southern town was suddenly disrupted by an influx of negroes, newly freed, and of several thousand northerners who came seeking a fortune in the turmoil of reconstruction. This was a period of confusion, of readjustment with the uncouth elements predominating. And the results are plainly visible on the face of the town: a chaos of small subdivisions, chiefly south of the original nucleus, each with its own street pattern and poorly integrated to the larger pattern, and streets of irregular width, even including Washington Street, the main north-and-south highway.

Vicksburg throughout this time was a unifunctional commercial town; although even before 1850 it contained railroad shops and cotton gins, which gave it somewhat of an industrial flavor. Commerce, however, was its dominant function; and this was at first largely retail, serving the plantations within a radius of not more than fifteen or twenty miles on the eastern side of the river. But the position of the town on the chief line of communication later gave it a strategic hold on the wholesale activities throughout a large portion of central Mississippi. Wholesaling consisted in part of supplying the retail stores of smaller urban communities; but in large part it consisted of buying, selling, collecting, and shipping the crop of cotton.

A number of events, however, combined to diminish the value of Vicksburg's position and to cut short its decade of rapid expansion. River traffic probably reached its height, if we may judge by the commerce of New Orleans, just before the Civil War. Even in the period after the war people did not quite realize the effect that rail transportation would have.[3] The river towns, Natchez and Vicksburg, were at a decided disadvantage as railroad centers. Along with the decline in river transportation came the shift of the river in 1876,

[3] Inland Water Transportation in the United States, *Bur. of Foreign and Domestic Commerce, Misc. Ser. No. 119*, Washington, 1923, p. 40; and F. H. Dixon: A Traffic History of the Mississippi River System, *Nat'l. Waterways Commission, Doc. No. 11 (1909)*, Washington, 1917.

not as serious in its consequences, however, as if it had taken place two decades earlier. Add to this a severe epidemic of yellow fever in 1878, which had its chief effect among the negroes, and it is easy to understand the decline in population from 12,443 in 1870 to 11,814 in 1880.

The last quarter of the nineteenth century was a period of stagnation for Vicksburg. Jackson, strategically located at a focus of railroad lines, was slowly growing, with nothing but the prestige of Vicksburg to keep it from usurping the wholesale functions. Furthermore, the increase of transportation facilities was leading to a greater diversification of the cotton markets; and Vicksburg, after playing a leading rôle, was becoming just one market among many others. Instead of reflecting the productivity of a large area of the cotton belt, especially of the fertile Yazoo-Mississippi delta to the north, Vicksburg came to depend more and more on the local cotton produced in Warren County.

The Present Town

Between 1900 and 1910 Vicksburg increased in population from about 14,800 to about 20,800. By 1920 a slight decrease had taken place, but the 1930 census shows a population of 22,943. Most of the gains and losses of this period are in the negro population, while the whites show a gradual and steady increase. In the meanwhile Jackson has forged definitely into the lead, especially in the 1930 census (48,282), and Natchez has dropped far behind (13,422). This increase in both Vicksburg and Jackson has resulted from a rapid increase in heavy industries.

Vicksburg at the present time (1929) contains some 39 industrial plants. Local industries account for 22 of these: of the remainder, nine manufacture lumber and timber products, such as furniture, flooring, boxes and crates, cooperage, and oars. To these Vicksburg presents something of an advantage in that the larger part of the timber is brought in by river. The other eight industries include cotton gins and compresses, a cottonseed oil plant, a mattress factory, and railroad and engineering shops for two railroads and for the government levee building and repairing equipment. The addition of these heavy industries in significant number to the unifunctional commercial town of the nineteenth century has produced the plurifunctional commercial and manufactural city of the present day.

Commercial and Industrial Areas

The commercial core, which makes up three per cent of the city, is and has been, since the first period of development, located along Washington Street, ascending the valley bluff at an angle. The commercial core includes the retail store district, which has for its

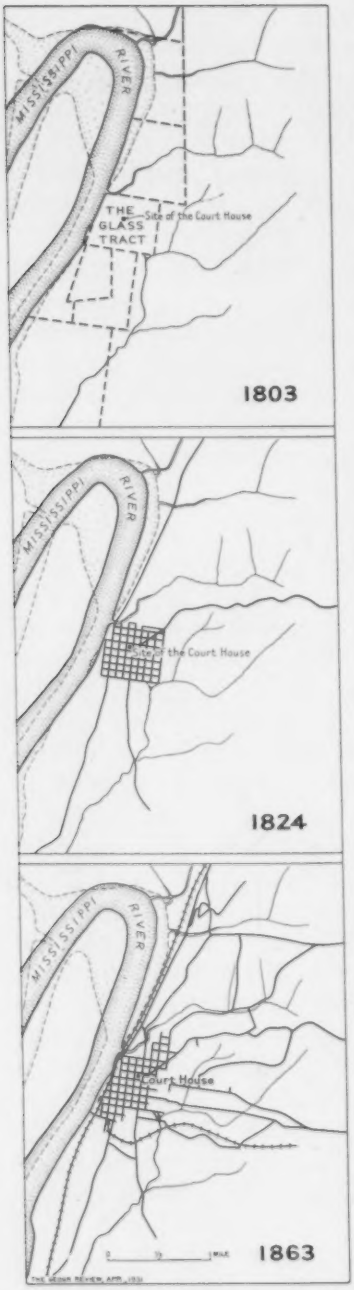


FIG. 5—Steps in the earlier development of Vicksburg. The Glass tract and other land grants near the site of Vicksburg, 1803, as surveyed in 1828; the layout of Vicksburg in 1824; the street pattern in 1863.

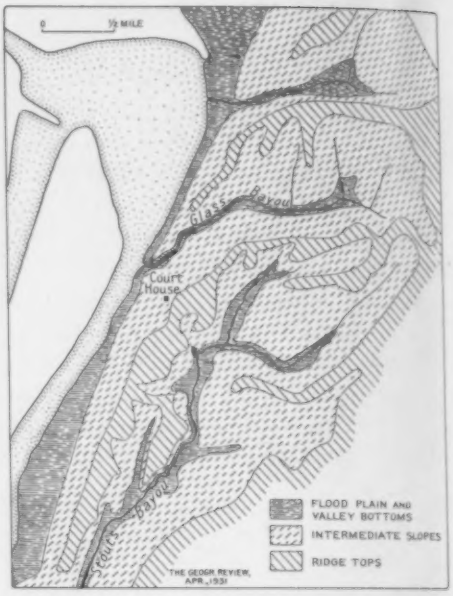


FIG. 6—The land surface of the site of Vicksburg.

function the service of the larger urban community and even of the outlying rural areas. It is characterized by buildings two, three, and four stories in height, although this general level is surmounted by an eight-story bank and office building and by the new twelve-story hotel. Brick is the prevailing material, and the architectural types are those characteristic at least of the eastern United States in the seventies, eighties, and nineties. With these types of buildings facing each other across a narrow street, now crowded with automobiles and street cars and overhung with a network of wires, the aspect of the commercial core is one which can be duplicated in its essential features in many of our older cities that have not added new construction in recent years. A larger percentage of the core is covered with buildings than any other district, and their height is greater.

FIG. 7—Vicksburg in 1929. A quantitative analysis of the area occupied by various utilities gives the following result in percentages: industries, 7; wholesale and storage, 2; commercial core, 3; lodging and boarding-house zone, 3; superior residence, 7; ordinary residence, 27; negro residence, 41; vacant or agricultural land within urban limits, 9; playgrounds and parks, 1. The total area in reference to which these percentages are measured is the area of the geographical city and does not include the agricultural and vacant land beyond the limits of urban development even though within the political city limits.

FIG. 8

FIG. 9

FIG. 10

FIG. 8—One of the homes of the superior residence district. (Photograph by Unglaub.)

FIG. 9—Ordinary residence district of the inner zone. (Photograph by Unglaub.)

FIG. 10—A section of the negro residence district. (Photograph by Unglaub.)

The wholesale district, comprising two per cent of the total area of the city, lies along the lower slopes of the valley bluff and the narrow flood plain along the water front. For the most part it shows unmistakable signs of decadence. Most of its structures are one-story brick or corrugated iron sheds built during the period of thriving wholesale activity. At present a large number, perhaps half, of these older buildings are unoccupied.

The maintenance of the wholesale function at Vicksburg has been accompanied by a renewal of activity in river transportation under government subsidy. The Mississippi-Warrior Barge Line maintains a floating dock on the Mississippi, south of the city, and rail connections between the dock and the wholesale and industrial districts. Rates are fixed by the Interstate Commerce Commission so that water shipments, including the cost of rail transshipment in the city, are lower than competing all-rail rates. Shipments by water increased from 80,000 tons in 1919 to 294,000 tons in 1928.

Cheap land and accessibility to lines of communication are the chief desiderata in the location of heavy industries within a city. These conditions are found, in general, on the urban periphery and on low, swampy lands not suitable for other utilities. In the case of Vicksburg, one group of industries is located on the river flood plain just south of the wholesale district, within the political city limits. Another group, consisting of five of the nine lumber and timber

products plants, is located two or three miles north, beyond the bend of the Yazoo; and several plants are located south of the city, one as much as five miles distant. These detached pieces, or ectochores, are distinctly a part of the city and owe their physical separation to the unfavorable terrain that intervenes. The numerous local light industries are scattered in characteristic positions throughout the city, but chiefly on the periphery of the commercial core.

The Residence Districts and Vacant Land

Of the total area of Vicksburg 78 per cent is taken up with residences. These are divided in this study into four districts—lodging-house, superior, ordinary, and negro districts. The arrangement of these four classes may be described in general terms as a series of concentric circles around the commercial core, this simple circular pattern being considerably modified by adjustment to the ridges and valleys. In general the better classes of residence take the ridge tops and the poorer classes the valley bottoms. Of the negro district, for instance, 20.4 per cent is located in the ravines, while only 12.5 per cent is on the ridge tops.

Residence subdivisions, chiefly occupied by negroes with some ordinary white residences, are scattered eastward along the ridges and are connected to the main portion of the city by ridge-top roads. The political city limits are formed by the inner boundary of the National Military Park. Beyond this park, attracted by the cheaper land outside and by the lower taxes beyond the city limits, there are several urban ectochores of fairly dense settlement, of a character similar to the ridge-top extensions within the city limits. These are all included within the geographical city. Excepting for the inclusions of vacant land in the south, Vicksburg is relatively compact, the few vacant areas within the main body of the city being made up of near-vertical walls of loess on which occupation is almost impossible, or of land close to the railroads or on the river flood plain valuable chiefly for industrial utilization. Perhaps it is a safe generalization that rapidly growing cities tend to include more such undeveloped land within the urban area, while slowly growing or static cities tend to fill in such spaces without expanding the limits.

In conclusion it may be remarked that the future of Vicksburg is bound up with the development of river transportation and with the more productive utilization of the loess uplands to the east and the Yazoo flood plain to the north.

THE IRON AND STEEL INDUSTRY OF SPARROWS POINT, MARYLAND

Langdon White and Edwin J. Foscue

FIG. 1

THE metallurgical industry of our country must in the future face the problem of the depletion of the Lake Superior iron ores, which now furnish about 85 per cent of the country's total consumption. In 1924 Burchard estimated that the 2,000,000,000 tons of the region would last about 33 years at the present rate of consumption—some 60,000,000 tons per annum.[1] When this source of ore is gone, the great districts in the Middle West must either find ways of utilizing the near-by low-grade Appalachian carbonate ores, which does not seem probable,[2] or they must procure their supply from abroad—from Brazil, Chile, Cuba, Mexico, Newfoundland, etc. In the latter event they will most certainly suffer a handicap from their interior location, even if the St. Lawrence Deep Waterway should become a reality. The advantage of a seaboard location such as that of Sparrows Point, Md., on the contrary will be emphasized. It is the purpose of this article to discuss the strategic location of this particular district.

Sparrows Point has the distinction of being the world's largest and America's only deep-water iron and steel district. It is also the only one in the United States using foreign ore almost exclusively.

The plant, one of the most comprehensive and best balanced in the country with a steel ingot capacity of more than 1,750,000 tons, was located on tidewater despite the fact that for many decades the frontier of steel making, along with that of population, was trekking westward. Nor has the step proved to be one of misjudgment. When the plant was acquired by the Bethlehem Steel Corporation in 1916 its sole product was steel rails. Capacity was expanded seven times in the decade 1916–1926, and today the plant, entirely redesigned and reconstructed, manufactures a wide and diversified group of products including pig iron, blooms, billets, sheet bars, slabs, rails,

[1] E. F. Burchard: Alabama Ores Equal Lake Supply, *The Iron Age*, Vol. 119, 1927, pp. 847–850; reference on p. 849.

The iron ore reserves covering developed and prospective ore in the ground and the ore in stock piles in Minnesota in 1928 were 1,258,232,624 gross tons and for Michigan 173,653,533 gross tons—a total of 1,431,886,157 gross tons. These estimates are furnished by the Minnesota Tax Commission and the Michigan Board of State Tax Commissioners.

[2] George Otis Smith, personal communication.

sheared and universal plates, wire rods, wire, skelp, tin and black plate, nails and staples, castings, pipe, and sheets.

Sparrows Point and the Baltimore Region

Though Sparrows Point is about ten miles from the center of Baltimore, it is geographically a part of that great metropolis and accordingly shares its many industrial and commercial advantages. Among the outstanding attributes of Baltimore are: It is one of the four principal gateways from the Atlantic to the interior United States; it is the second foreign-trade port of the country in tonnage; it takes precedence over all other Atlantic ports in intercoastal service to the Pacific coast; it is the "most western of the eastern ports, the most northern of the southern ports, and the most southern of the northern ports";[3] it is located at the mouth of the Patapsco River at the very limit of tidewater, not on the main bay but rather at its boundary where railways have a freer range;[4] it lies on the Chesapeake and Delaware Canal, which links Chesapeake and Delaware bays; it lies relatively near the great coal fields of Pennsylvania and West Virginia; it secures Chilean and Cuban ores economically at its water-side blast furnaces; it lies strategically with respect to great markets —local, growing industrial South, Greater New York, and foreign; it possesses an adequate supply of good industrial water; it has plenty of room for future growth; and it lies in the most important region of general manufacture.

Site of the Plant

Sparrows Point itself is located at the head of tidewater on the distal end of Patapsco River Neck near the river's mouth about 160 statute miles from the Virginia capes. It falls within the Atlantic Coastal Plain which, with its nearly level topography, is ideal for the development of a huge steel center. The entire near-by area is embayed, the sea occupying the ancient valley of the Susquehanna, thus forming Chesapeake Bay and converting into estuaries the lower reaches of its tributaries, on one of which—the Patapsco—Sparrows Point and Baltimore stand.

The harbor front has been developed for commerce from Hawkins Point on the south shore to Sparrows Point on the north shore, so that the large freighters carrying ore from Chile to Sparrows Point can dock with comparative ease. The Patapsco has been dredged so that there is a new channel 90 feet wide and 40 feet deep leading from the Government channel, which is 600 feet wide and 35 feet deep.

[3] G. H. Poulder: The Port of Baltimore, *Manufacturers Record*, Vol. 95, 1929, March 21, pp. 51–56; reference on p. 54.

[4] Walter Lefferts: Tidewater Maryland, an Embayed Coast Plain, Philadelphia, 1918, p. 63.

Assembly of Raw Materials: Iron Ore from Chile

Sparrows Point does not have a single raw material at hand: it gets ore from Chile, Cuba, and elsewhere; coal from Pennsylvania and West Virginia; and limestone from Pennsylvania. On first

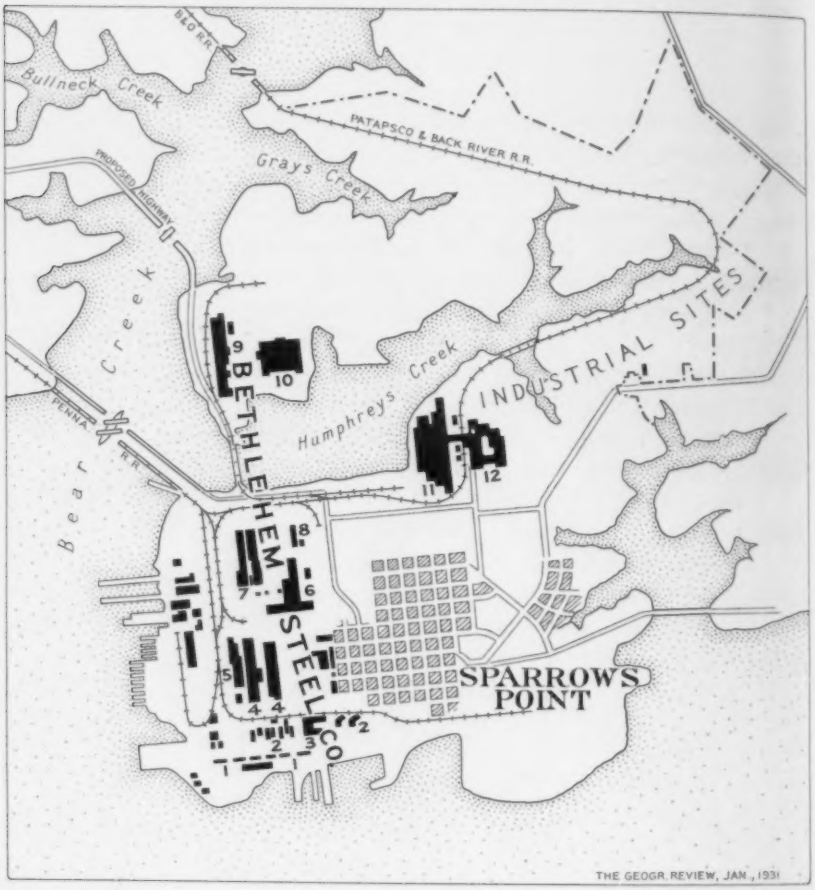


Fig. 2—Map of Sparrows Point (redrawn from map supplied by Mr. C. H. H. Weikel). Compare general view in Figure 3. Numbers have reference: 1, coke ovens; 2, blast furnaces; 3, electric power and blowing engines; 4, open-hearth steel departments; 5, rail mill; 6, blooming mills; 7, plate mills; 8, skelp mill; 9, rod and wire mill; 10, pipe mills; 11, tin plate mills; 12, sheet mills. The scale of the map is approximately 1 inch to 3700 feet.

thought one might suppose that its assembly costs would be exceedingly high, yet such is not actually the case. Nearly all the ore moves via water and mostly in the company's own vessels. The long cheap ocean haul and the short rail haul bring the South American and Cuban mines, the chief sources, economically closer to the blast furnaces than the mines in the Lake Superior region. Furthermore, much of the coal—especially that from West Virginia—travels by the rail-water route; from Norfolk it is transported to Sparrows Point

in Bethlehem colliers. Another matter that should be taken into account at this point is the quality of the ore. Whereas Mesabi ore from the Lake Superior region runs only about 51 to 52 per cent metallic iron, Chilean ore runs about 65 per cent.

From Tofo, near La Serena, more than a million and a half tons of high grade iron ore arrive each year at America's eastern seaboard, largely at Sparrows Point.

FIG. 3—General view of Sparrows Point. A complete industrial community is seen here: the plant, the homes of the employees, schools, stores, churches, and theaters. (Photograph by courtesy of the Bethlehem Steel Corporation.)

The ore body consists of two hills separated one from the other by a slight depression. The ore is a mixture of hematite and magnetite and is hard, dense, abrasive, and relatively free from impurities—running 65 per cent metallic iron. A large reserve tonnage is available. The mining is done by blasting and resembles to a marked degree trap-rock quarrying as carried on in the United States. The ore is scooped up by huge electric shovels, loaded into cars, and taken to a hillside crushing plant. From the crusher it is whisked to the docks at Cruz Grande. While the mines at Tofo are separated from tide-water by only four miles as the crow flies, the standard-gauge railroad is 15 miles long and is laid out in four lateral loops on account of the mountainous relief. The short railroad is electrified; and the loaded cars in their journey down to the sea generate power for returning the empty ones.

At Cruz Grande a basin 900 feet long, 240 feet wide, and 40 feet deep has been excavated out of solid rock for accommodating the large ore carriers, which can be loaded in all kinds of weather. Here also has been erected a huge steel dock, which rises 123 feet above low tide. It is surmounted with three tracks and is equipped with two steel bins, each holding 15,000 tons of ore, which is poured by gravity into the boats through 17 chutes.

The fleet of specially built vessels for transporting the ore consists

of the largest freighters bearing the American flag.[5] Hatches are distributed down the long deck, and as soon as the vessel is made fast these are opened. From the ore pockets above are let down chutes, which are folded flat against the pockets when not in use. Through the open doors of the pockets a stream of black ore thunders into the hold so swiftly that a 20,000-ton ship is loaded in five hours. The round trip from Sparrows Point to Cruz Grande requires about 40 days, and coal is frequently taken as return cargo. Bethlehem freighters frequently carry to Cristobal 20,000 tons of coal from the Norfolk and Western docks at Lambert Point, which is on the direct route from Sparrows Point to Cruz Grande. These terminals can handle 30,000,000 tons of coal annually.[6] The fuel is dumped from railroad hoppers into specially designed, electrically operated conveyor cars, each having a capacity of 100 tons. The conveyor cars are carried to the top of Pier No. 4 by elevators, which have a combined capacity of 60 trips an hour, and to the top of Piers Nos. 2 and 3 by inclined approaches. As many as 20,000 tons have been placed aboard an ore carrier in 13 hours.

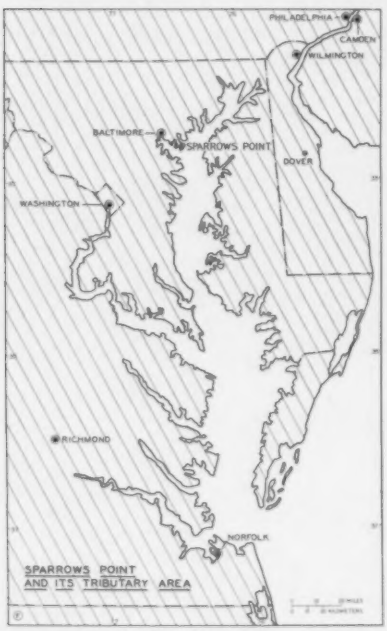


FIG. 4—Map showing Sparrows Point in relation to its tributary area. Scale 1 : 4,750,000.

An interesting point in connection with the transportation of iron ore is the toll through the Panama Canal, which may average as low as 40 cents a ton because tolls are based not on the weight of the cargo but rather on the cubic capacity of the ship.

CUBAN AND OTHER SOURCES

Cuba was formerly the chief source of ore for Sparrows Point, but this is no longer the case. In fact, in 1928 only 369,286 gross tons were shipped to the United States.

[5] That Bethlehem's fleet does not transport all the ore is indicated by the following item from the *Baltimore Sun* of October 12, 1929 (p. 19, column 1): "The Greek steamer Theifana, the Norwegian steamer Eir and the Jugo-Slav steamer Gundulic have been chartered for ore cargoes from Cruz Grande, Chile, to Baltimore for October loading. The British steamer H. M. Aisquith will load in November. The ore is for the Bethlehem Steel Works, at Sparrows Point."

[6] "The Ports of Hampton Roads," *Hampton Roads Maritime Exchange Annual, 1929*, Norfolk, Va., 1928, p. 40.

Ore is mined in several parts of the island republic, but the greatest development has occurred in the eastern section. In 1928 about 86 per cent of the shipments consisted of hematite, including a small amount of magnetite, from the Daiquiri and Juragua mines on the southern coast, and 14 per cent of brown ore from the Mayari mines near the northern coast.[7] While the iron content of these ores varies greatly, it averages about 55 per cent for hematite when dried at 212° F. and about 54 per cent for the brown ore nodulized. Because Mayari ore contains nickel and chromium, it is far better for the manufacture of ordnance and structural steel than domestic ores.

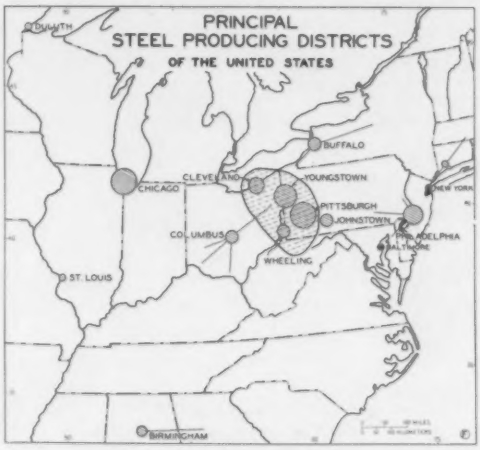


FIG. 5—Iron and steel districts in the eastern half of the United States as grouped by the Federal Trade Commission in the Pittsburgh basing case (1922).

The size of the circles is proportional to the ingot capacities of the districts. The arrows point to cities having plants that are included in this particular districting scheme. The shaded area bounded by the heavy black line is the Middle District—the greatest metallurgical region in the world. (Data from *The Iron Age.*)

Ore is also brought thither from Algeria, Australia, France, Morocco, Newfoundland, Norway, Spain, and Sweden. It is brought from Spain and Sweden because of special qualities rather than because of low cost; whereas it comes from France because ore serves as return cargo for ships carrying raw materials and foodstuffs. Newfoundland ore is used largely because it is near and costs little. Ore from Norway originates in northern Sweden; during the winter, when the Gulf of Bothnia and the Baltic Sea are frozen over, ore from northern Sweden is sent by rail to the Norwegian port of Narvik for shipment abroad.

Other Raw Materials

Sparrows Point's chief disadvantage is its considerable distance (350 miles) from sources of blast furnace fuel and consequent high fuel assembly costs.

The coal used here comes from the Pocahontas, New River, and Fairmont fields in West Virginia and from the Clearfield and Westmoreland districts of Pennsylvania. The tonnage from the two states is just about evenly balanced: in 1923 Pennsylvania supplied

[7] H. W. Davis: Iron Ore, Pig Iron, and Steel in 1928, *Mineral Resources of the United States, 1928, Part I*, U. S. Dept. of Commerce, Washington, 1929, pp. 29–68; reference on p. 51.

637,159 tons, and West Virginia 535,903.[8] While some of this coal is conveyed all the way by rail, some is carried part of the way by barge and steamer. All that delivered by the Western Maryland Railway must use the float stage from Baltimore, since Sparrows

TABLE I—COST OF ASSEMBLING COAL AT SEVERAL MAJOR METALLURGICAL CENTERS

DISTRICT	SOURCE OF COAL	MEANS OF CONVEYANCE	COST PER TON
Birmingham . .	Warrior Field	Rail	$ .57 net ton
Buffalo	Pittsburgh	"	2.24 " "
Chicago	Eastern Kentucky and West Virginia	"	3.09 " "
		Rail-water	2.59 " "
Cleveland . . .	Connellsville	Rail	1.90 " "
	Kanawha	"	2.39 " "
	Pocahontas	"	2.64 " "
Pittsburgh . . .	Connellsville	"	1.26 " "
	Along Monongahela River	Water	.15 " "
Sparrows Point .	Pocahontas and New River	Rail	3.60 gross ton
	Westmoreland	"	2.96 " "
	Fairmont	"	2.96 " "
	Clearfield	"	2.71 " "
Youngstown . .	Connellsville	"	1.42 net ton
	Pittsburgh	"	1.34 " "
	Kanawha	"	2.39 " "
	Pocahontas	"	2.64 " "

Point is accessible in no other way. Much also is brought up from Hampton Roads in the company's own steamers, since it is more economical than the all-rail route. The coal storage and handling plant receives more than 2,000,000 tons of fuel annually.

The only by-product coke plant in Maryland is that at Sparrows Point, which lies advantageously with respect to Baltimore, a large market for surplus gas. The 360 ovens here make each year more than 1,350,000 net tons of coke—a yield of about 73.4 per cent. The ovens have an annual coke capacity, however, of 1,750,000 net tons.

All the limestone (nearly 400,000 tons in 1928) used at Sparrows Point comes from the Hanover Quarry in Adams County, Pennsylvania, about 65 miles distant, since it is the most available source of

[8] F. G. Tryon and H. L. Bennit: Coke and By-Products in 1923, *Mineral Resources of the United States, 1923, Part II*, U. S. Geol. Survey, Washington, 1926, pp. 427–497; reference on p. 455.

supply suitable for the type of smelting employed. The quarry is owned by a subsidiary of Bethlehem Steel Corporation and has very elaborate equipment—a drag-line excavator for removing the overlying clay, which averages about six feet in thickness, a steam shovel, cable haulage and rock house, gyratory crusher, trommels, etc.[9]

The limestone is carried to Sparrows Point by the Western Maryland Railway for $0.90 per gross ton from Bittinger, about two and a half miles northwest of Hanover. This is more than is paid by Cleveland ($0.45 by water) and by Youngstown ($0.55) but less than by Pittsburgh ($1.13).

When scrap is charged into open-hearth furnaces, economies are effected, time is saved, and a product is made which is the peer of that derived from pig iron alone. Nevertheless the economical production of pig iron continues to be the "only permanent foundation for a vigorous and stable steel industry." Sparrows Point, like other steel centers, uses much scrap both "plant" and "market." The bulk originates within the works themselves, but much is also brought in from the tributary area because of its intense industrialization and its great railway net.

Few industries have such vast water requirements as the one under consideration, water being used for cooling, gas washing, and steam. Most districts adjoin rivers or lakes, whence they draw their supply, but the Maryland plant, despite its locus on the Patapsco River, cannot use the brackish water of this tidal estuary.

Fortunately, artesian horizons are present which supply all the water needed. They produce approximately 458,000 gallons of water an hour, which is enough for the blast furnaces, foundries, and steel mills, with some left to supply the needs of the ships that bring in the raw materials and carry away a large part of the manufactured products. The most important horizon lies at a depth of about 600 feet and almost invariably yields large quantities of good industrial water. It is overlain by several less important horizons at depths varying from 30 to 40 feet. All the wells (59 in 1918) have an altitude of 10 feet and vary from 98 to 611 feet in depth. Only 20 have soft water, and these serve for boiler use.

In all probability, Sparrows Point's water supply is of better quality than that of Pittsburgh, Youngstown, or Cleveland, whose river waters are utilized repeatedly, are polluted, and have high temperatures from continuous usage.

The Steel Distribution Problem

The economical distribution of steel is the industry's most baffling problem. Cross haulage is common because nearly every district's

[9] B. L. Miller: Limestones of Pennsylvania, *Pennsylvania Geol. Survey, Bull. M7 (4th Ser.)*, Harrisburg, 1925, p. 100.

capacity exceeds the requirements of its near-by territory. Consequently, each seeks to extend its markets in the direction of its competitors. This is especially pronounced in the Middle District, which has a capacity exceeding that of all the rest of the country combined and, despite tremendous consumption, nevertheless of necessity seeks other marts.

TABLE II—MOVEMENT OF STEEL PRODUCTS IN OFFICIAL TERRITORY, 1925

DISTANCE MILES	TONNAGE PER CENT
1–100	32.5
101–200	15.8
201–300	15.3
301–400	14.5
401–500	11.3
501–600	5.2
601–700	3.5
701–800	.8
801–900	.6
901–1000	.3
above 1000	.2
	100.0

Sparrows Point is excellently located with respect to the markets of Baltimore and its environs, New England, New York, New Jersey, and eastern Pennsylvania, the Gulf Coast, the Pacific Coast, and foreign lands. In each case the far-reaching significance of its salt-water location, which gives it the major advantage to be derived from contact of land and water traffic, is emphatic since the district ships about a third of its total output by water. Moreover, 47 per cent of the ingot capacity and 34 per cent of the manufactured iron and steel production of the Eastern District, which includes New England, eastern New York, New Jersey, eastern Pennsylvania, Maryland, and Delaware, is controlled by the Bethlehem Steel Corporation.

Baltimore and its hinterland are rapidly developing into a great industrial region, and many heavy industries—users of iron and steel—are, after making careful surveys, locating here. The transport advantages offered by this district are highly significant. Such heavy commodities as steel cannot justify long hauls and costly transportation by rail, a fact borne out in Table II. Such being the case, Sparrows Point naturally makes a wide range of products, which are purchased by the transforming industries in the immediate tributary area. For instance, the greater part of the output of the tin plate mills is consumed here, much being used by the canning industry, centering in Baltimore.

THE DOMESTIC MARKET

New England, Greater New York, New Jersey, and eastern Pennsylvania comprise one of the country's most important steel consuming areas. For instance, New York City is the nation's, as well as the world's, most important market for structural steel and bids fair to retain its precedence indefinitely, inasmuch as skyscrapers in ever-growing numbers are reaching farther and farther into the clouds. The new Empire State Building, for instance, has a height of 1250 feet. In 1929 the city had 188 buildings of more than 20 stories, and the number is steadily growing. Certainly there will be no end to this building and rebuilding.

Furthermore, the eastern seaboard region is the most densely populated section of the country and has the densest railway net, with a detailed and intricate railway pattern that is reflected in enormous car, locomotive, and track requirements. The important place in

TABLE III—CONSUMPTION OF STEEL IN THE UNITED STATES*
(PERCENTAGE OF ESTIMATED TOTAL STEEL OUTPUT)

INDUSTRY	1922	1923	1924	1925	1926	1927†	1928†	1929†
Railways	22	27	28	25	23	19	16	17
Buildings and Construction	15	15.5	18	17.5	19	22	16.5	16.5
Automotive	10	11	10	13	14	14	18	18
Oil, Gas, Water, and Mining	10	10.5	9	8	9	8.5	9.5	10.5
Export	7	6	6	5	5	5.5	6.5	5.5
Food Containers	4	3.5	4	4.5	4	4.5	5	5
Machinery	..	3	3.5	3.5	4	4	3.5	3
Agriculture	4	4	3	3.5	4	5.5	6.5	5.5
All other	28	19.5	18.5	20	16	17	18.5	19

*Docket No. 17,000, Rate Structure Investigation, Part 6: Iron and Steel Articles, Interstate Commerce Commission, Washington, 1927, sheet 39.
†*The Iron Age*, Vol. 125, 1930, p. 10.

steel consumption of the railways and of building and construction is indicated in Table III. In 1928 automobiles, for the first time in the history of the industry, took first place in steel consumption.

The same region is also a great mart for wire. Sparrows Point with its new wire mill, just recently placed in operation, is undoubtedly the most favorably located for supplying it. While this same market is readily accessible to Worcester, Mass., where the nation's wire industry was born and where it still is very important, that city's mills suffer by comparison with Sparrows Point in not being self-contained. Whereas everything used by the Maryland plant's wire mill is made on the spot, the pig iron used in Worcester and even some of the billets must be brought from the west at high freight rates —$5.92 per gross ton of pig iron from Pittsburgh and $6.88 from Cleveland. Also the eastern market can be reached by Sparrows Point at freight rates (on wire) substantially one-third less than those from Pittsburgh and Cleveland.

Sparrows Point competes for the large and ever-growing market of the Gulf Region with Pittsburgh and Wheeling, which freight huge tonnages of steel down the Ohio and Mississippi rivers; with Birmingham, which sends steel by barge down the Black Warrior and Tombigbee rivers; with Chicago and Gary, which ship by rail to Cairo and St. Louis and thence by barge over the Mississippi;

and with Belgium, England, France, and Germany, whose bottoms engaged in carrying cotton to northwestern Europe offer low freight rates on manufactured products rather than return in ballast. For instance, the vessel rate on steel from Antwerp or Liverpool to Galveston is only about $3.55 per ton which, with import duty added, means a delivery cost considerably less than the rail rates from

FIG. 6—Freighter of the Bethlehem company's line at Sparrows Point. Bottoms of this type carry the company's products to Pacific Coast ports.

American mills. Even the rail rate from Birmingham to Galveston is $12.77 per ton.

Quite recently Bethlehem opened a warehouse at Houston, Texas, to which it sends large tonnages of products, especially pipe for the oil industry, for distribution throughout the entire Southwest. Naturally this material moves by water.

New building is advancing rapidly on the Pacific Coast, though it is less impressive than in the East and Middle West, which have the bulk of the population. The region itself supplies from 20 to 25 per cent of its needs for steel.

Formerly the Pacific Coast was dominated by the Chicago-Gary district, but the Panama Canal, completed in 1914, had the effect of drawing the two seaboards together and at the same time, figuratively speaking, of causing rail rates to move Chicago and Gary farther from tidewater. Thus intercoastal traffic by keel replaced transcontinental trade by rail, and the rapidly growing Pacific Coast market became an "economic appendage," in so far as iron and steel are concerned, of the eastern seaboard and Birmingham. Belgium, England, France, Germany, and India also send iron and steel to this market. Today the Chicago manufacturers are not important factors in the trade.

FOREIGN MARKETS AND FOREIGN COMPETITORS

There is little doubt that the rapid growth of the plant at Sparrows Point was designed for its functioning in export trade, since the plant's site undeniably gives it the best relative accessibility to foreign marts.

Yet the total exports are small indeed, as are those of the United States as a whole. Of a total of 21,939,636 tons of international trade from the five leading metallurgical manufacturing countries in 1928, America's share was only 13.06 per cent, or 2,865,103 tons (3,032,352 gross tons in 1929). The other four countries divided the remaining tonnage about evenly:

Belgium-Luxemburg	4,871,680
France	5,631,819
Germany	4,309,716
United Kingdom	4,261,318.

Sparrows Point makes all the five items that comprise about three-fourths of our country's total exports—tin plate, galvanized and black steel sheets, rails, and welded pipe. These products are carried to the far corners of the earth, many of them in the corporation's own bottoms—for Bethlehem owns a steamship line for transporting its own products as well as those of secondary industries to the ports on the Pacific Coast. Sailings are made every nine days from Sparrows Point, Baltimore, and Philadelphia direct to such ports as Los Angeles Harbor, San Francisco, Oakland, Seattle, and Portland.

Also the Patapsco and Back Rivers Railroad makes connections with three trunk railroads: the Baltimore and Ohio, the Pennsylvania, and the Western Maryland. Thus a secondary metallurgical industry located at or near Sparrows Point can ship its products direct by rail or by water.

If Sparrows Point is the best located American district with respect to foreign markets, its natural domestic market (the Atlantic, Gulf, and Pacific seaboards) is the most vulnerable to foreign invasion, since foreign products seldom penetrate inland farther than 200 miles, because of railroad freight rates. European rails, it is true, are laid down in Detroit, French cast-iron pipe in Chicago, and British low phosphorus pig iron in Chicago; but the tonnages to date are small, and most of these products come all the way by water—reaching lake ports via the St. Lawrence-Great Lakes waterway.

Belgium, France, Germany, the United Kingdom, and India successfully undersell American producers along our periphery in pig iron, cast-iron pipe, and bars and shapes. This is possible despite a tariff of $1.12½ a ton on pig iron and from $6.00 to $15.00 per net ton on steel, because of lower labor costs, lower transportation costs from plants to seaboard, and lower assembly costs on raw materials (except in the case of Birmingham).

Expansion No Problem

The majority of the largest and most modern plants are in districts where there is an abundance of cheap, level land for expansion and

growth—places where the actual plant layout may be carried on scientifically. This does not mean, of course, that the availability of flat land in large tracts is a major factor in the location of the iron and steel industry—save as determining the specific site within a given district—for it is a minor one in comparison with propinquity

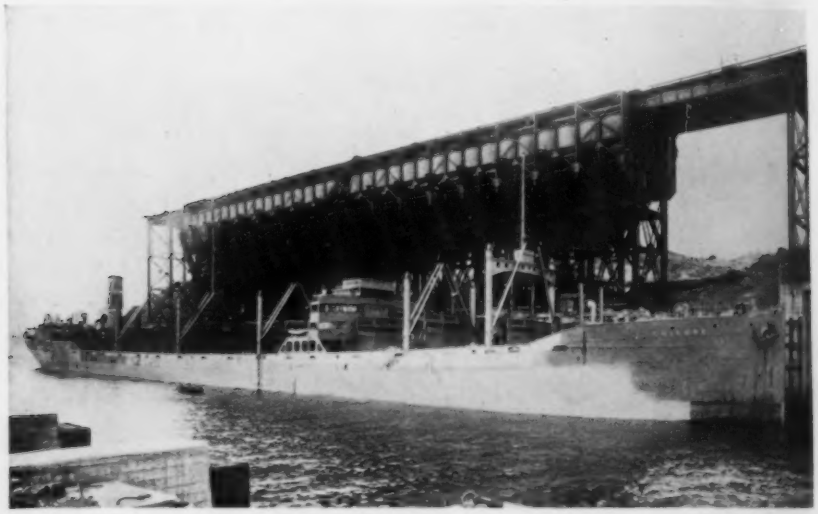


FIG. 7—The steamer *Chilore* at the ore dock, Cruz Grande, Chile, taking on iron ore for Sparrows Point. (Photograph by courtesy of the Bethlehem Steel Corporation.)

to raw materials or to markets. Nevertheless, large tracts of cheap land are imperative on account of the nature of the industry, which makes heavy products and therefore needs single-story buildings. Moreover, the economics of the situation make it necessary to reduce the cost of manufacture to an absolute minimum. The tremendous expenditures at most plants in recent years—$25,000,000 at Lackawanna, $20,000,000 at Johnstown, $40,000,000 at Homestead, etc.—have been primarily for the purpose of lowering the cost of production and not for increasing capacity. Thus the steel mills are placed as near as possible to the blast furnaces in order to utilize molten pig iron rather than hardened or cold pigs. Furthermore, secondary industries like to locate near the primary one, which nurtures them. At Sparrows Point the Bethlehem company has almost 3000 acres—enough to take care of all future demands. This great tract of flat land, only ten feet above tide, lies where land and water traffic merge—an ideal site for a great steel plant.

THE LABOR SITUATION

Important aspects of the labor situation in the region of Baltimore and Sparrows Point are that it has the lowest living costs of our 31

leading cities; a small proportion of foreign-born occupants; and the "highest proportion of home ownership with large settled population." The Bethlehem company owns Dundalk, a town of approximately 7000 inhabitants, midway between Baltimore and Sparrows Point on the car line, railroad, and proposed main highway between Baltimore

FIG. 8—Loading tin plate and sheet metal aboard a Japanese freighter for the Far East.

and Sparrows Point. It acquired this tract for the purpose of developing a modern home community. It sells lots and homes and has a plan for financing its employees who work at the Maryland plant.

Some 10,000 workers are employed at the Maryland plant (1931). Yet considering the amount of work actually accomplished and the tremendous tonnage produced, it is an exceedingly small labor force. This is consequent upon the universal adoption of labor-saving machinery, which is necessary because of the high cost of labor—four times what it is in Belgium and France. Since 1914 the increase in output per man-hour in the American metallurgical industry is more than 60 per cent. Less than 80 persons, including all classes of workers, produce as much as 100 did a quarter of a century ago, despite a shorter working day. Data collected in 1926 by one of the large steel companies (not Bethlehem but comparable for our purpose) showed the following gains over 1902 in the tonnage handled or produced per man-hour in the following departments: ore unloading, 706.7 per cent increase; blast furnaces, 277.3 per cent; Bessemer ingots, 99.8 per cent; open-hearth ingots, 66 per cent, and rails, 120.1 per cent.[10]

Probably the most valuable point this paper can contribute in regard to labor is its cost relative to the cost of steel. Writers have

[10] *The Iron Trade Rev.*, Vol. 82, 1928, January 5, p. 14.

diverged so far in this matter that their readers have scarcely known what to accept. The following statement is believed to be accurate: that the over-all labor item in a ton of rolled steel is probably about 50 per cent.

Summary

This study has indicated what a highly strategic site the Maryland plant occupies. It has stressed the cogent and unmistakable importance of the interrelation of raw materials, markets, and transportation. It has shown that a tidewater position in a densely populated industrial region enables the plant to assemble raw materials and discharge manufactured products *easily*, *quickly*, and *economically*. It has further pointed out that this is America's best located district for importing foreign ores and for exporting manufactured products to foreign lands, and that while this is perhaps of only minor importance now, it will be very important in the future when our metallurgical industry must depend upon imported ore and when our manufacturers enter an era of serving foreign markets.

THE MODOC LAVA FIELD, NORTHERN CALIFORNIA

Martin A. Peacock
University of British Columbia

ASSOCIATED with the Cordillera of North America is a great belt of igneous rocks stretching from the Alaskan Peninsula to Central America. Within this belt regions of active vulcanism are few and relatively restricted in extent; but areas which suffered volcanic catastrophes on a gigantic scale in a period no more remote than the time of the last glaciation are perhaps greater in extent than is generally supposed. Such a territory is the Modoc Lava Field in the extreme north of California, where hundreds of square miles of jagged and corded lava, scores of almost perfectly preserved cinder cones of which each was once an imposing volcano, and barren mountains of volcanic glass that represent acidic effusions of impressive dimensions stand as testimony to a series of great volcanic events in recent geological times.

FIG. 1—Map showing the situation of the Modoc Lava Field and its relation to the principal peaks of the Cascade Range. Scale of the map approximately 1:11,500,000.

So interesting are the natural features of the region that an area of about 73 square miles in the north-central section has been set aside as a national monument.[1] As the theater of one of the last important North American Indian risings against the United States government the Modoc Lava Bed area is also of historical interest. In 1870 the Modoc Indians, a handful of people led by Captain Jack, deserted from the Klamath Indian reservation and returned to their original land around Lost River on the Oregon boundary. In November of 1872 a military detachment from Fort Klamath attempted to force the Modocs back to the reservation; they resisted and fled to the Modoc Lava Bed where the caverns and fissures and the natural difficulty of the country gave them a great advantage over the attacking force. Captain Jack with his fifty-one fighting men lost

[1] Harold T. Stearns: Lava Beds National Monument, California, *Bull. Geogr. Soc. of Philadelphia*, Vol. 26, 1928, pp. 239–253.

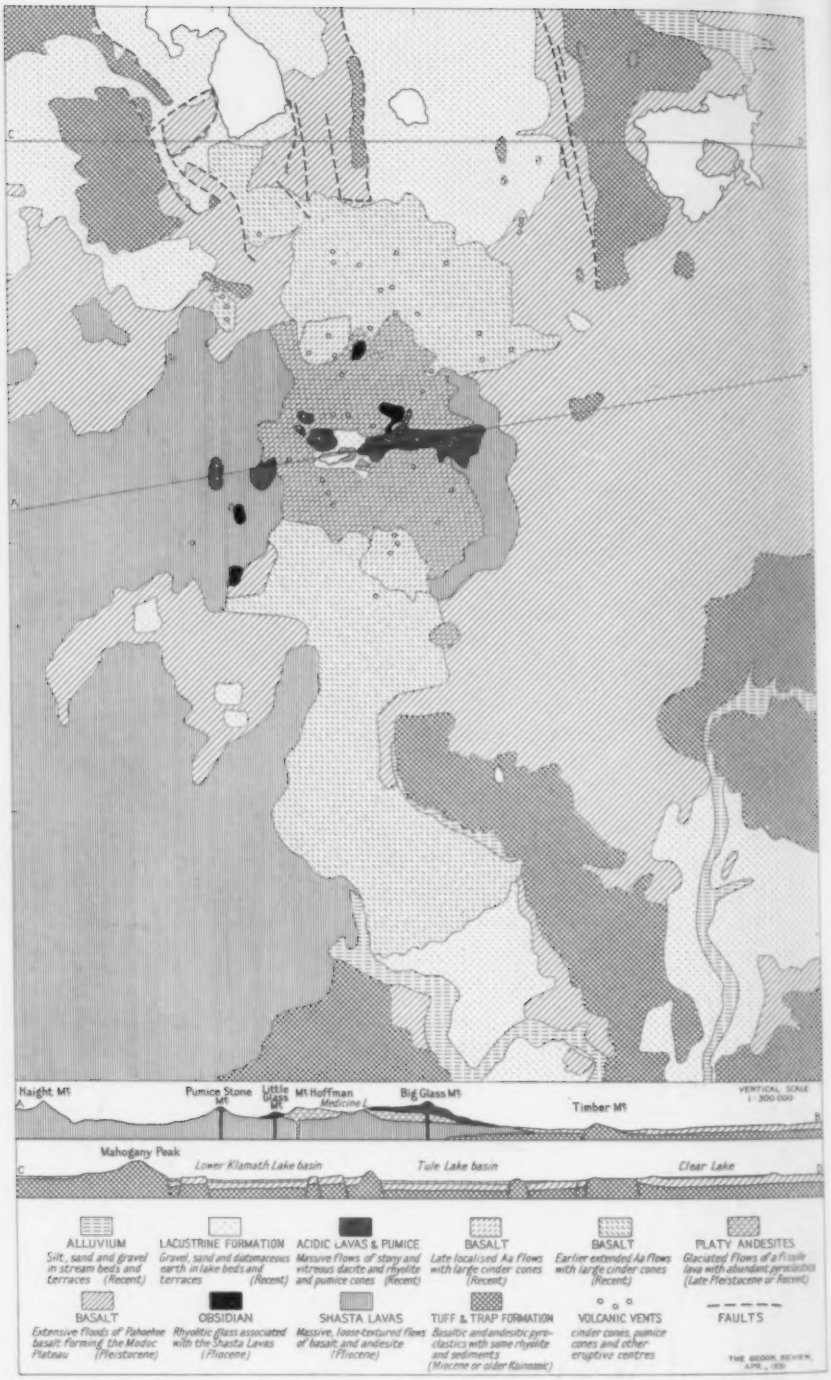

Haight Mt
Pumice Stone Mt
Little Glass Mt
Mt Hoffman
Medicine L
Big Glass Mt
Timber Mt
VERTICAL SCALE 1:300 000
Mahogany Peak
Lower Klamath Lake basin
Tule Lake basin
Clear Lake
ALLUVIUM
Silt, sand and gravel in stream beds and terraces (Recent)
LACUSTRINE FORMATION
Gravel, sand and diatomaceous earth in lake beds and terraces (Recent)
ACIDIC LAVAS & PUMICE
Massive flows of stony and vitreous dacite and rhyolite and pumice cones (Recent)
BASALT
Late localised Aa flows with large cinder cones (Recent)
BASALT
Earlier extended Aa flows with large cinder cones (Recent)
PLATY ANDESITES
Glaciated flows of a fissile lava with abundant pyroclastics (Late Pleistocene or Recent)
BASALT
Extensive floods of Pahoehoe basalt forming the Modoc Plateau (Pleistocene)
OBSIDIAN
Rhyolitic glass associated with the Shasta Lavas (Pliocene)
SHASTA LAVAS
Massive, loose-textured flows of basalt and andesite (Pliocene)
TUFF & TRAP FORMATION
Basaltic and andesitic pyroclastics with some rhyolite and sediments (Miocene or older Kainozoic)
VOLCANIC VENTS
cinder cones, pumice cones and other eruptive centres
FAULTS

FIG. 2—Geological reconnaissance map of the Modoc Lava Field, by Martin A. Peacock and Howard A. Powers, 1927. See Figure 3 for topography, place names, and scale.

FIG. 3—Topographic map of the Modoc Lava Field, to be read in connection with Figure 2. The topography is after the U. S. Geological Survey's reconnaissance sheet Modoc Lava-bed, 1 : 250,000 (compare Fig. 1), surveyed in 1884–1885, and the official maps of Shasta and Modoc National Forests.

only five of this number in fair fight, while the Federal detachment of a thousand men supported by artillery lost a hundred lives and cost the government two million dollars.

THE AREA AND ITS GENERAL SETTING

The area with which the present paper is concerned (Fig. 1) is the one-degree quadrangle Modoc Lava-bed of the United States

Topographical Survey. On this reconnaissance sheet the topography is tolerably well represented but, owing to the pronounced shrinkage of the lakes in recent years and additions and alterations to roads and trails, the map is now erroneous in these respects. However, the United States Forest Service maps of the Modoc and Shasta National Forests represent the present lake shores and communications fairly well. Published geological information on the area is scanty and somewhat inaccurate.[2] In fact, it could be said that nothing was definitely known about the area except that it is occupied mainly by young volcanic rocks. The writer had an opportunity to engage in field work in the region in 1927[3] in collaboration with Dr. H. A. Powers of Harvard University, now with the United States Geological Survey. The present paper is virtually a report of joint work.

The Modoc region is conveniently reached either from McCloud, Cal., a lumber station to the southeast, or from Klamath Falls, Ore., to the north. Within the area there is a system of primitive roads from which almost any point can be reached on foot. These roads are maintained for the most part by the Forest Service for connecting lookout stations and reaching fires; and they are traversable by automobile from early in July until the first snows in September. Each car is obliged to carry a shovel and ax to assist, if necessary, in combating forest fires; these implements are also indispensable for clearing fallen timber and the snowdrifts still encountered in July.

Entering the field early in July, 1927, Dr. Powers transported the first load of supplies to our base camp at Medicine Lake and made a preliminary traverse of the area. On July 9 the writer arrived at McCloud, and the joint field journal dates from July 10 to August 23. Throughout this period the rainfall was confined to a single thunderstorm, and the diurnal temperature ranged from 0° on the coldest nights to 100° in the shade on the hottest afternoons. In many parts of the area water is wholly unobtainable and had therefore to be carried for drinking and for the radiator of the car. By the use of a slightly porous canvas water bag the contents were kept tolerably cool by superficial evaporation. At times mosquitoes

[2] J. S. Newberry on a transcontinental railroad survey in 1854–1855 traversed the quadrangle from south to north by an easterly route from Pit River to Lost River. *33rd Congr., 2nd Sess., House Ex. Doc. No. 91*, Vol. 6, 1857. See also the geological map of California by J. P. Smith (1916), on a scale of about 12 miles to one inch.

[3] The suggestion came from Professor D. H. McLaughlin of Harvard University, and the opportunity to carry out the plan was offered primarily by the traveling facilities given to the writer by the Commonwealth Fund Fellowship. Professors Charles Palache and E. S. Larsen of the Department of Mineralogy and Petrography placed a further grant at our disposal; Professor R. A. Daly lent a number of valuable instruments; Professor G. D. Louderback of the University of California, Dr. R. J. Russell of the Louisiana State University, and Dr. H. T. Stearns of the United States Geological Survey gave useful information. In the field we were assisted by many, especially by Mr. R. Lang of McCloud, Cal., who gave us free use of a hunting cabin on Medicine Lake, and by various officers of the United States Forest Service.

became a source of serious discomfort, and anyone camping under canvas in the region visited would do well to provide adequate protection against insects.

The Trans-Cascade Plateau

The Modoc region forms a part of the high, semiarid plateau adjoining the Cascade Mountains on the eastern side. In Washington and northern Oregon this plateau belongs to the physiographic province of the Columbia River Plateau; in southern Oregon and northern California it has affinities with the Great Basin province. Lying in the extreme north of California, in a transitional position, the Modoc quadrangle exhibits features characteristic of both regions: little-eroded plateau surface, mountains of volcanic accumulation, and mountainous and hilly regions owing their configuration to dislocations and to erosion.

In the Modoc area this trans-Cascade plateau has a general elevation of about 4500 feet. Rising to a maximum height of 3500 feet above this level are a number of wide mountainous and hilly areas; and, entrenched to a depth of more than 2500 feet below the general plateau surface, the Pit River marks the lowest level in the region. The mountainous and hilly areas are of three types distinct in geological structure and history and in resulting physiographic expression.

The Old Tuff and Trap Hills

The first and oldest type of highland is built of tilted tuff and trap hills in the south, southeast, and north. The rocks, the oldest in the region (early Tertiary), consist of a series of dense dark basalts of extrusive and intrusive character, massive accumulations of basic, intermediate, and acidic tuffs and breccias, minor bodies of intrusive acidic rocks, and water-laid sediments of various kinds, the relative proportions of these components varying from place to place. The hills form wide tracts rising from 500 to 1500 feet above the general plateau level. They also occur as single, prominent horsts surrounded by younger formations in Timber Mountain, Double Head, Indian Butte, and the conspicuous ridge bounding the west side of the Tule Lake basin. In the main, they have mature rounded forms due to the common preponderance of pyroclastic material; but occasionally bands of harder rock produce prominent scarps giving the terraced appearance familiar in trap hills. As the now detached hills and highlands certainly represent only remnants of a once continuous, or at least more extensive, formation, the development of the present physiography may be related either wholly to erosion or to fracturing of the original formation followed by differential

FIG. 4

FIG. 5

FIG. 6

FIG. 4—Dislocated and eroded horsts (early Kainozoic tuff and trap formation) which rise from the sedimentary plain of Lower Klamath Lake basin. Looking west from near Dome Mountain.

FIG. 5—Block-fault topography in the basaltic lavas of the Modoc Plateau between the basins of Tule Lake and Lower Klamath Lake.

FIG. 6—The Modoc Lava Bed (Recent basalt), looking south from an escarpment of the Modoc Plateau near the southwest corner of Tule Lake basin. In the left distance are many Recent basaltic cinder cones; the sky line on the right is formed by the northern rampart of the Central Volcanic Dome.

FIG. 7

FIG. 8

FIG. 7—Medicine Lake, looking north from the southern rampart. On the extreme right is Big Glass Mountain; in the middle is Mt. Hoffman.
FIG. 8—A portion of the rim of Pumice Crater, four miles northwest of Medicine Lake. On the extreme left is seen a later obsidian flow which spilled into the crater.

subsidence of the dislocated blocks which were then modified by erosive agencies. The degrees of tilting observed and their variation point to the second alternative, and this conclusion is strengthened by analogy with similar and indisputable structures in a younger formation which will be described later.

After the block-faulting or during its successive stages erosion undoubtedly cut back the fault faces of the upstanding horsts to a greater or less degree, and therefore the present hill fronts cannot usually be regarded as marking the original block-fault planes. But in the northern part of the area a number of well defined, relatively little-eroded scarps occur on the blocks west of Clear Lake and in the Tule Lake and Klamath Lake basins. Most of these scarps trend roughly north and south in conformity with the main structural trend of the country, while a few of them make high angles with that direction. It seems certain that these scarps are not far removed from actual block-fault planes, and they have been marked as such on the map, Figure 2.

It is clear that the first phase of vulcanism in the Modoc area was mainly explosive in character and related to the activity of central vents. This activity was evidently often interrupted by periods of quiescence when sediments, mainly lacustrine, were laid down; and there is evidence that the dislocations in consequence of which great tracts of the territory were down-faulted and covered by younger formations originated during this period of intermittent explosive vulcanism. In the McCloud River, a few miles west of the western limit of the sheet, the oldest volcanics may be seen resting on pre-Tertiary rocks; the volcanics are thus certainly Tertiary and not younger than Miocene. In the Modoc quadrangle, however, no evidence was found on which a closer dating than early Tertiary could be based.

The Shasta Lavas Highland

To the second type of highland belongs the broad, irregular, mountainous belt occupying the midwestern and southwestern parts of the region and extending east to the Central Volcanic Dome, appearing at a few points under volcanic accumulations near the middle of the dome, and emerging in an arcuate outcrop around its eastern margin. To the west, in the adjoining quadrangle, this mountainous area merges into the base of Mt. Shasta, whose snow-clad peak rises to a height of 14,617 feet and forms a prominent and helpful landmark clearly visible from most parts of the Modoc quadrangle.

These regions are composed mainly of a massive, deeply dissected series of gray, loose-textured lavas, mainly andesites and basalts with some subordinate rhyolite obsidians, very different from the

dense, dark traps occurring in the older formation. The massive gray lavas were apparently delivered from central volcanoes of the Shasta type. Because of the lithological and physiographical similarities with the actual products of Mt. Shasta, they are here termed Shasta Lavas.

The territory occupied by the Shasta Lavas exhibits a relief of over 6000 feet, the maximum in the Modoc area. Haight Mountain, near the western margin, exceeds 8000 feet; Garner Mountain and Horse Peak exceed 7000 feet; Grizzly Peak and several other conspicuous mountains rise above 6000 feet; while the Pit River cuts into the formation below the 2000-foot level. The configuration of this territory has been determined mainly by erosion, and undoubtedly the deep dissection of the southwest block was effected by rivers such as the Pit and McCloud and their tributaries. At the same time the present form of the territory seems to be in a measure dependent on initial irregularities. Many of the peaks crowning the highland that joins the central dome with the base of Mt. Shasta have a deeply ravined conical or pyramidal shape so similar

FIG. 9

FIG. 10

FIG. 11

FIG. 9—Looking north across the Modoc Lava Bed: on the right a Recent basaltic cinder cone; in the middle distance two small vents.

FIG. 10—Burnt Lava Flow, with large cinder cone, immediately south of the Central Volcanic Dome.

FIG. 11—Pumice Stone Mountain, a twin dome with a large breached crater in the smaller member.

to that of Shasta itself that they are more likely to be ruins of volcanoes of the type of the Cascade peaks than simple remnants of erosion of a plateau region.

The Shasta Lavas weather readily and produce abundant gray soil supporting the heaviest timber growth in the Modoc area. For

FIG. 12—In the well timbered terrain of the Shasta lavas, seven miles east of Horse Peak.

this reason extended outcrops of bare rock are scarce, and such questions as the thickness and attitude of the flows remain unanswered. For the same reason the delimitation of the formation is in some places arbitrary.

On somewhat slender evidence the Cascade peaks are generally regarded as Pliocene volcanoes, and no evidence has been found that is at variance with this conclusion. The Shasta Lavas are therefore taken as Pliocene on the basis of their general similarity to the lavas regarded as Pliocene in the Cascade province.

THE MODOC PLATEAU

The third and youngest type of highland has resulted from recent volcanic accumulations, and its forms have been only insignificantly influenced by tectonic or erosive agencies. The Modoc Plateau occupies more than one half of the entire sheet and maintains a general level of 4500 to 5000 feet. Except for areas occupied by ancient lake beds the surface of the plateau is built entirely of a series of basaltic lavas; the oldest of these were erupted after the Shasta Lavas, while the youngest cannot be more than a few centuries old. The lavas of the plateau are divisible into three groups distinct in age, in mode of eruption, and in their respective influences on the appearance of the plateau surface.

The oldest group is by far the thickest and most extensive. Where the flow surfaces of this group are still preserved, as they are around the horst of Timber Mountain, they present the relatively smooth, ropy, gently undulating appearance characteristic of basaltic lavas erupted in a state of high fluidity; and thus they are comparable

FIG. 13—A great flow of Recent subvitreous dacite forming the southeastern extremity of Big Glass Mountain.

with the *pahoehoe* flows of Hawaii and the *helluhraun* of Iceland. Visible vents in the form of cinder cones, slag cones, or conspicuous domes are wholly absent in the older lavas of the Modoc Plateau, and the many favorable natural sections fail to reveal any pyroclastic material or any trace of central vents. Since the plateau has suffered but slight erosion it is inconceivable that large central volcanoes had existed and are now completely obliterated. It therefore seems that the main component of the Modoc Plateau was built by a long series of eruptions of hot and fluent lava welling quietly from inconspicuous vents.

The second group of lavas includes the Modoc Lava Bed proper and the larger area lying to the south of the Central Volcanic Dome. These lavas are characterized by a greater roughness of surface, abundant vents in the form of low lava domes, cupolas and cinder cones, and a scanty covering of sagebrush.

To the third group belong the recent flows—Callahan Flow on the northern edge of the Central Volcanic Dome and Burnt Lava Flow at its southern margin. These lavas have exceedingly rough, tumultuous, and slaggy surfaces which are almost wholly free from vegetation; and thus they compare with the *aa* flows of Hawaii and the *apalhraun* of Iceland. Both Callahan Flow and Burnt Lava Flow are surmounted by great cinder cones whose original shape and crater depressions are

almost perfectly preserved. It is clear, then, that as the Modoc episode came to a close vulcanicity became localized and explosive in character, while the extruded lavas were notably cooler and less fluent than the earlier effusions.

Physiographically the Modoc Plateau is especially interesting as it shows on a large scale and in a convincing manner block-fault, or horst-and-graben structure. The northern part of the plateau surface, especially the areas around Lower Klamath Lake basin, Tule Lake basin, and Clear Lake, is traversed by a series of long, roughly rectilinear escarpments most of which trend in a general north-south direction while a few run about at right angles to this direction. Some of these escarpments are rather low and defaced; others again are bold, steep cliffs varying in height from 200 to 400 feet or more. The escarpments in that part of the plateau lying immediately west of Tule Lake basin are especially clearly defined, and they serve to illustrate the nature of those that are less conspicuous. On the map and the section C-D are indicated four of the more prominent escarpments west of Tule Lake; these can be traced for a distance of 6 to 12 miles. Three of these escarpments face east, while the plateau dips gently to the west from the top of each cliff to the base of the one lying next to the west; the fourth escarpment faces west. The gently inclined surfaces of the plateau blocks are strikingly flat and clearly close to the original flow surfaces; and thus the physiography can be related only to a series of parallel north-south fractures followed by slight similar rotations of the separated blocks about north-south axes, resulting in steep escarpments facing east and gentle slopes dipping west.

In a recent paper by R. E. Fuller and A. C. Waters[4] much weighty evidence is presented for the usual view that the horst-and-graben structure in southern Oregon is related to normal faulting that results from tension and therefore against the growing idea that compression producing reverse faulting was the tectonic agent. In the Modoc Plateau no reason was found for invoking reverse faulting. Fracturing and differential subsidence are common features in volcanic plateaus, and the irregular withdrawal of underground support due to continued extrusions of lava seems to provide a means of causing stresses which will result in dislocations and irregular subsidence of the dislocated blocks. Such stresses would certainly not be compressive in the effective direction, namely in the plane of the plateau surface; they would be irregular in nature and would have certain tensional components in the effective direction which would be the proximate cause of fracturing.

[4] The Nature and Origin of the Horst and Graben Structure of Southern Oregon, *Journ. of Geol.*, Vol. 37, 1929, pp. 204–238. It may be noted that the distinction implied by the authors between block-fault structure and horst-and-graben structure does not have significance in the area discussed in the present article.

Regarding the age of the Modoc Plateau, again, little evidence was found. The two youngest groups of lavas are undoubtedly Recent; and the earliest and principal series is later than the Shasta Lavas and apparently considerably so, since the Shasta Lavas are deeply dissected while the Modoc Plateau is hardly appreciably eroded. It may most probably be placed as Pleistocene.

The Central Volcanic Dome

While the Modoc Plateau was being built up by a series of outpourings of common basaltic lava extending far beyond the limits of the Modoc quadrangle, volcanic activity of a very different nature took place within a roughly circular area some 16 miles in diameter with Medicine Lake near its center. Around an extinct volcanic focus of the period of the Shasta Lavas activity was vigorously resumed. At first large bodies of fluid andesitic lavas were erupted. These lavas have a striking platy structure. The eruptions then became explosive in character, and many large andesitic cinder cones were formed. After an interval of quiescence activity began again. This time lavas of a different nature, subacidic and thoroughly acidic glassy lavas (subvitreous dacite and rhyolite obsidian), were extruded in great volume from several points in the terrain and, in some cases, actually from the former vents. Finally this acidic activity took an explosive turn, and pumice cones were built up quite close to the obsidian flows.

These volcanic events, resulting in the production of materials of progressively increasing acidity, took place wholly or largely in recent geological time. The platy andesites are conspicuously polished and scratched by ice; but this ice was highland ice doubtless much later than the continental ice of the Pleistocene glaciation. The andesitic cinder cones are but little modified in form, and the glass flows are almost barren of vegetation and very recent in appearance. At the extremity of Big Glass Mountain blocks from the obsidian flow are piled against a great dead cedar which, while still rooted, is bent away from the lava flow and is charred on the side facing it. The lava is thus younger than the tree, which itself is perhaps 500 years old. The pumice eruptions were the last volcanic manifestations in the region, and it is probably these to which the Modoc Indians refer in their legendary account of local volcanic catastrophes.

The accumulated products of this restricted volcanic episode constitute the Central Volcanic Dome. The slopes of this dome fall sharply to the plateau level on the north, east, and south sides; to the west the dome merges into the mountainous terrain of the Shasta Lavas (section A-B). The dome is crowned by an incomplete, roughly circular rampart of mountains rising to about 8000 feet and en-

FIG. 14—Little Glass Mountain, built of Recent flows of rhyolite obsidian covered with slag in concentric waves, four miles west-southwest of Medicine Lake.

compassing a flat, irregular basin, some three miles across, within which lies Medicine Lake at a height of about 6500 feet.

The mountainous rampart surrounding the central basin is built mainly of large, coalescent cinder cones of the platy andesite episode, partly by isolated cones such as Little Mt. Hoffman and partly by the western front of Big Glass Mountain. The volcanic form of the isolated cones is clearly apparent; the original dome shape of most of the components of the rampart is obscured, however, by the interpenetration of adjacent members and by superficial erosion and decay permitting a heavy growth of timber. The pumice cones are similar in shape to the andesite cinder cones; but, whereas the latter are brown or red and well-timbered, the former are nearly white and practically bare and much more conspicuous. Pumice Stone Mountain, seven miles west of the west end of Medicine Lake, is the youngest and best preserved of the pumice cones. It is a twin dome, the higher member of which rises about 600 feet above the surrounding country, while the other, which has the appearance of a parasitic cone with a wide, breached crater, is somewhat lower (Fig. 11).

The great flows of dull, subvitreous or stony dacite and of lustrous, black rhyolite obsidian are perhaps the most arresting spectacles in the Modoc quadrangle. The map shows that these lavas are geographically connected, as they are genetically, with the main mass of the central dome. The largest of these bodies of acidic lavas, Big Glass Mountain, spreads over an estimated area of 16 square miles and rises to a height of nearly 8000 feet above sea level, or about 1000 feet above its foundations. Viewed from a distance the mountain has a marked terraced appearance which is seen in the photograph and on the section along the line A-B on the map. This profile is the result of repeated outpourings of viscous lava from a centrally located vent, each outpouring being smaller than the preceding one, producing a pyramidal pile of sheets with beveled edges that represent the steep flow fronts. On the west side, where the lavas flowed towards the Medicine Lake basin, there are three conspicuous terraces; and on the long eastern slope seven such steps can be counted.

FIG. 15—Tule Lake basin, a block-fault trough in the Modoc Plateau.

THE RIVERS AND LAKES

Owing to the small annual precipitation in the Modoc quadrangle and the permeability of many of the rock formations, permanent lakes and streams are few; and these are restricted to the extreme south and the extreme north of the region, leaving the central part almost wholly destitute of surface water. Pit, Fall, McCloud, and Lost rivers are the chief streams. The older maps show Lost River flowing into the north end of Tule Lake; but, as far as we could ascertain, the small body of water carried by Lost River is now dissipated in irrigating the land around the northern limit of the sheet, the area that was originally occupied by the Modoc Indians. The remaining streams are mostly unimportant in size and intermittent in character.

On the older maps the largest lake in the quadrangle is Tule Lake (Rhett Lake of the first reports), lying in the northern part of the region. When surveyed in 1884 Tule Lake had an area of 150 square miles; by 1924 the lake had shrunk to about half that area; and now it is represented by a small and shallow pond, which appears to be rapidly vanishing. Similar recent shrinkage has been suffered by Lower Klamath Lake, which lies west of Tule Lake. Clear Lake, on the other hand, has been increased in area by an irrigation dam. The lake sediments shown on the map lie almost exclusively on the lavas of the Modoc Plateau, and therefore these areas were occupied by lakes after the formation of the plateau and, according to the writer's estimate, in the late Pleistocene or in Recent time. On the east side of the Tule Lake basin, however, lacustrine sediments are exposed under the older lavas of the Modoc Plateau and thus show that even more extensive lakes existed before the Modoc lavas were poured out. The thickness of the lacustrine series is to be measured in hundreds of feet.

The following appear to be the main events bearing on the origin and history of the lakes. Towards the end of the volcanic period in which the older lavas originated, probably towards the close of the Miocene, the country was traversed by a series of fractures trending

roughly north and south in accordance with the main trend of the Basin Range faulting. Irregular differential subsidence of the dislocated blocks produced horst-and-graben structure and initiated vigorous degradation. The Modoc Plateau lavas were then poured out on the comparatively level sedimentary plains lying between the horsts, and renewed crustal movements along the north-south fractures produced the horst-and-graben structure of the plateau, as already described. Again erosion and sedimentation were promoted, and the wide areas of lake sediments shown on the map were deposited.

The rapid shrinkage of the lakes in recent historic time is surprising. In a small measure it has been accelerated by reclamation operations in southern Oregon, but in the main the causes are natural, being either a rapid reduction in the precipitation or an increase of the outflow channels. This phenomenon of lake shrinkage is general in the Cascade province, and the usual inference of a recent climatic change involving decreased precipitation seems to be well supported here.

Another influence may be contributing to lake shrinkage. Tule Lake has no surface outlet; and, although the wide basin is now almost dry, there are no conspicuous saline deposits. Water not evaporated must therefore be escaping by seepage, and it seems possible that continued escape of this kind might result in an increase of the size of the passages or that crustal disturbances connected with recent vulcanicity may have caused considerable underground channels which have served to drain the lakes in a short time.

Medicine Lake has a different origin. Situated at a volcanic focus surrounded by a roughly circular rampart of volcanic rocks, this lake has the appearance of a caldera, or crater lake; but closer examination shows that this appearance is deceptive. A rough hydrographic survey showed that about one half of the bottom is less than 20 feet deep, while the deepest sounding, 146 feet, was obtained at the middle of a funnel-shaped depression near the eastern end. The rocks exposed around this end of the lake are massive basalt flows belonging to the Cascade Lavas; but there is abundant evidence that these rocks are deeply eroded and that therefore the funnel-shaped depression revealed by our soundings cannot be a crater depression. The roughly circular disposition of the cones and flows surrounding the lake seems to be simply related to circular fractures which accompanied the last phase of the building of the Central Volcanic Dome; and the lake has resulted from the accumulated precipitation on the area enclosed by the wall of volcanic accumulation. Medicine Lake has at present no surface outlet, but the water is clear and fresh. Like the other lakes and from the same causes it has shrunk considerably in recent times.

Economics of the Region

The Modoc quadrangle is poor in natural resources. Diatomaceous earth occurs in notable quantities in the vicinity of Pit River in the south and about three miles west of Dome Mountain in the northwest. Exposures indicate that considerable quantities of apparently pure material are available in situations from which it could be excavated and transported without great cost. At the east front of Little Glass Mountain there is a small abandoned crusher in which obsidian was presumably crushed for some economic purpose, perhaps for insulating or abrasive material. The dry lake beds offer almost unlimited supplies of sand and gravel, and they are occasionally excavated and sorted for building and road-making purposes. Other than these there are no deposits of economic value in the region.

Timber is by far the most valuable product, and the greater part of the Modoc quadrangle lies in the United States Forest Reserves. The distribution of the timber is determined by the nature of the terrain, by water supply, and to a slight extent by altitude. The trees, which are exclusively conifers, grow profusely on the loose-textured, soil-covered Shasta Lavas and on the andesitic pyroclastics of the Central Volcanic Dome; these are sufficiently decomposed to invite growth, which is further assisted by sufficient water supply. The terrain of the older tuffs and traps is mainly less favorable for timber growth. The true basalt plateau is generally free from timber except near the eastern boundary, where better water supply has evidently counteracted the unfavorable nature of the ground: the plateau typically carries only sagebrush and a few stunted junipers. Cones of andesitic scoria and pumice and regions covered with a pumice mantle from the recent eruptions carry a fair growth of timber; but the recent basaltic and acidic lavas and the dry lake beds are nearly destitute of trees.

Owing to lack of water agriculture is very restricted. On the alluvium of Pit River and Lost River there is some mixed farming. By irrigation the lake beds adjoining the alluvial ground can also be utilized to a small extent; and the reclamation and irrigation operations now in progress immediately north of the northern boundary of the map may lead to further agricultural developments of the northern lake flats.

ECONOMIC GEOGRAPHY OF THE GRAY-BROWNERTHS OF THE EASTERN UNITED STATES*

Louis A. Wolfanger
School of Business, Columbia University

WERE foremost distinction in geographic significance to be accorded to any of the light-colored great soil groups of the eastern United States, such recognition would be due the gray-brownerths.[1] Their agriculture is of the greatest diversity: nearly every type of crop produced in the cooler middle latitudes is well represented. The high proportion of their area under cultivation is matched only by the richer dark-colored prairyerths and blackerths. The aggregate value of their crops approximates one quarter of the total annual value of all the crops of the United States. Other noteworthy relationships include the large number of farms operated by white owners, the high density of rural population, and the moderate amount of fertilizers used on these soils.

Like all great soil groups, the gray-brownerths embrace soils in various states of development.[2] A rather complete gamut ranging from infancy to senescence may be discerned, but for simplicity only three broad categories, mature, immature, and abnormal types, will here be recognized.

The Mature Gray-Brownerths

The most striking external feature of mature gray-brownerths is the general sameness of color. Throughout their extent, from the Atlantic Coastal Plains to the Ozarks, the basic coloration of the upper, or A horizons, is brown or grayish brown. The B horizon, or subsoils, show a similar range of color, except that the colors are typically lighter because of a lower content of organic matter. As a whole,

* This is the first of a series of studies under preparation on the geography of the great soil groups of the United States and their chief subgroups. The study is based on a simplified soil map prepared by the author on which numerous like or closely related soil series have been grouped into more inclusive and more easily comprehended units. Lack of space necessitates omission of specific references to the publications of the many soil workers whose labors have contributed to this survey.

The author is indebted to the Bureau of Chemistry and Soils for permission to use its soil survey publications and the unpublished soil map of the United States, prepared by the Soil Survey, for data employed in the preparation of the map.

[1] Gray-brownerths are also widely distributed in the West, but space considerations exclude their presentation in this paper.

[2] On the modern concepts of soil evolution see particularly the publications of Marbut and other soil scientists of America or Europe. A summary treatment is included in the writer's "The Major Soil Divisions of the United States" (1930). And see also his paper "Major World Soil Groups and Some of Their Geographic Implications," *Geogr. Rev.*, Vol. 19, 1929, pp. 94–113.

yellowish tints tend to prevail in the more northern, and reddish in the southern soils, the higher temperatures giving rise to the reddish oxides of iron.

The most significant physical feature of these soils is the rather resistive nut-like structure of the finer-textured types. When cultivated, the aggregates break down more slowly than those of other light-colored humid soils. They are less durable than the granular aggregates of the prairyerths or blackerths. Yet, after extended cultivation, the soils present no serious obstacles in a physical way if properly managed.

Chemically, in their natural state, the soils are notable for their mild acidity and moderate degree of leaching. They are low in soluble mineral and organic constituents, yet not so low as the light-colored groups, and the amount is appreciable. When cleared, they prove to be highly productive for several years.

The strong physical constitution of these soils is obviously their most important asset. It furnishes the primary key to the diverse agriculture of the gray-brownerths and to the great proportion of their area under cultivation, especially in the three regions of mature soils centering about western Ohio and northern Indiana, the Lake Ontario Plain, and southeastern Pennsylvania. The extended cultivation is partly a matter of topography but more significantly a soil relationship. Were the level terrain of these regions mantled chiefly with old soils, or soils of great physical imperfection, their topographic form would not have been sufficiently conducive to such extended utilization. With a favorable physical constitution, however, it has been profitable to fertilize and manure these soils when their limited natural supply of plant foods became exhausted.

Moreover, the mature gray-brownerths may readily be built up to meet the peculiar requirements of any crop climatically tolerant of the region. Since they are naturally quite low in plant foods and but mildly acid, simple addition of the essential constituents is all that is ordinarily necessary. It is this flexibility which makes possible their diverse agriculture and which contrasts so strikingly with the relative rigidity of the richer dark-colored groups. Witness in this connection the diverse agriculture of Western Europe where the gray-brownerths are very intensively utilized for grains, vegetables, fruits, hay, herbs, and flowers.

The Calcific Type

Although substantially alike as far as broad fundamental characteristics are concerned, the mature gray-brownerths may be divided into two secondary types, calcific and non-calcific. The calcific is the less leached of the two, its structure aggregates are more resistive,

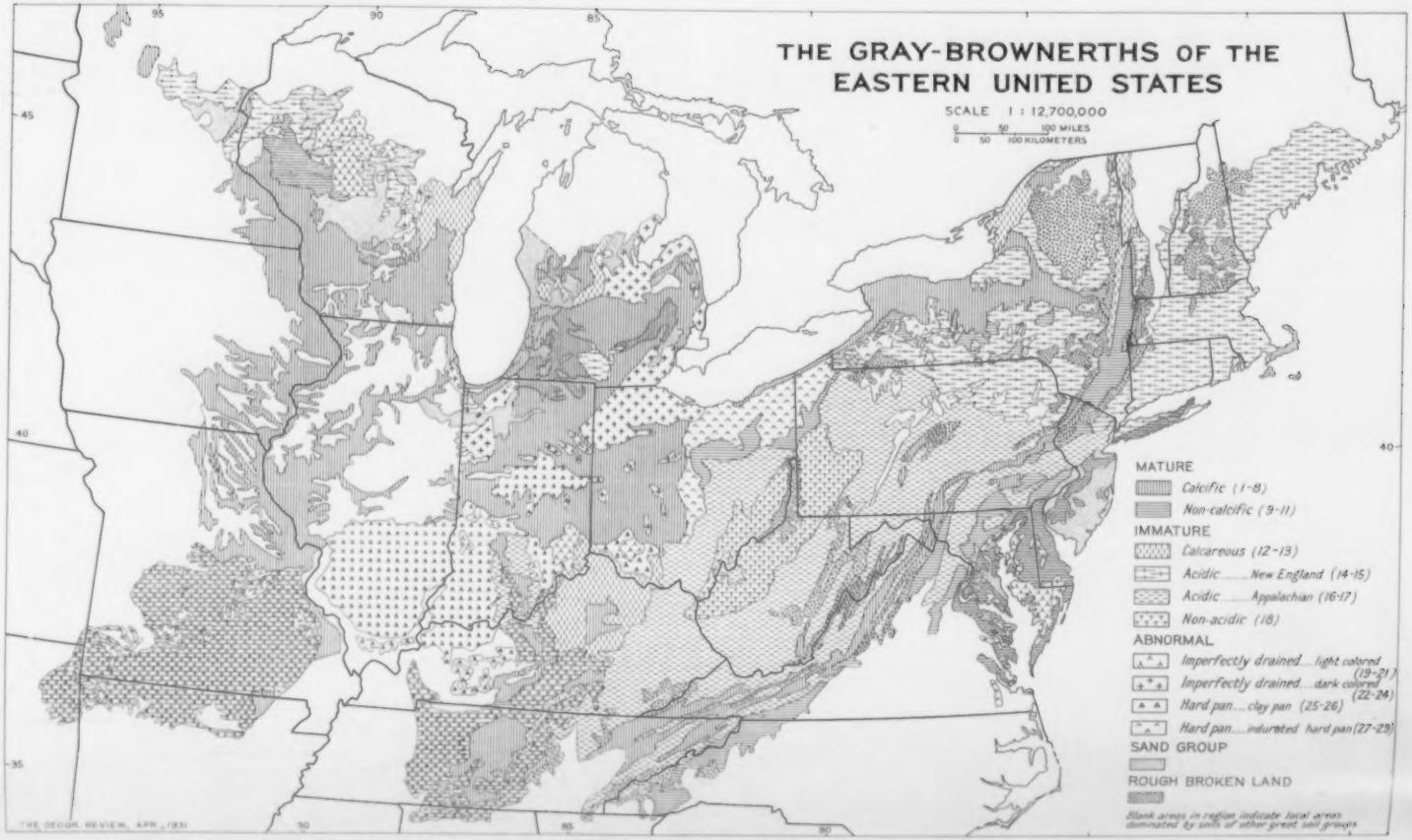


FIG. 1—The gray-brownerths of the eastern United States. The map aims to show the areas in which the group indicated predominates. Outside the areas qualified by the chert and sand symbols the textures are in general of the loam, silt, or clay types. Mature soils are shown by solid lines, immature soils by corresponding broken lines, and abnormal soils by non-linear symbols. The numbers in the legend apply to the economic areas defined in the key map, Figure 2.

chert and sand symbols the textures are in general of the loam, silt, or clay types. The map aims to show the areas in which the group indicated predominates. Outside the areas qualified by the soils by non-linear symbols. The numbers in the legend apply to the economic areas defined in the key map, *Figure 2*.

KEY MAP TO ECONOMIC AREAS
SCALE 1 : 12,700,000
0 50 100 MILES
0 50 100 KILOMETERS
The stippled areas are not dominated by gray-brownerths or are not specifically discussed in the text
THE GEOGR. REVIEW, APR., 1931

FIG. 2—Key map to economic areas: 1, Northern Dairying; 2, Ohio-Indiana Corn-Belt-Farming; 3, Upper Mississippi Upland Stock-Farming; 4, Kentucky Inner Blue Grass; 5, Nashville Basin Stock-Farming; 6, Appalachian Valley General and Specialized Farming, and Bedford, Ind., and Ozark Districts; 7, Ozark Agri-Grazing; 8, Highland Rim Agri-Grazing; 9, Coastal Plain Truck and Fruit; 10, Eastern Appalachian General Farming and Dairying; 11, Northwestern Appalachian General Farming and Dairying; 12, Kentucky Outer Blue Grass; 13, Northern Milk and Cheese; 14, Lower New England-New York Milk; 15, Upper Lakes Cheese and Butter; 16, Central Appalachian Agri-Forest; 17, Triassic Lowland General Farming and Dairying; 18, Upper Ohio Sheep; 19, Central Wisconsin Cheese; 20, Indiana-Ohio Corn-Wheat-Timothy; 21, Eastern Shore Potato and Strawberry; 22, Maumee Corn and Sugar Beet; 23, Saginaw Sugar Beet and Bean; 24, Kankakee Corn-Belt-Farming; 25, Ohio Valley Grain and Hay; 26, Central Indiana Grain; 27, Chesapeake Bay Subsistence; 28, New York-Ohio General Farming and Dairying; 29, Highland Rim and Ozark Stock-Farming.

and the soil mass remains in better physical condition under cultivation. Derived from formations relatively high in calcium-bearing minerals, it has retained some of the beneficial effects resulting from the presence of these materials, albeit, like the non-calcific type, it is now low in lime. It is more responsive to fertilizers and, where leaching has not extended to too great depths in the case of the underlying parent material, the carbonates of this formation prove beneficial to long-rooted plants.

Economically, this subgroup has no worthy equal. Taken as a whole and compared with other secondary groups of humid light-colored soils of the eastern United States, it shows a larger share of its area in high-grade cultivation or pasture. Limited space precludes any detailed account of the varied use, but several type studies will probably make clear the more important relationships. It will be noted that each represents a balance between two conditions—the peculiar features of the soils on the one hand and the particular economic or other local environmental limitations on the other.

The Northern Dairy Areas. The northern areas—those extending as a broken belt from the Ontario-Mohawk lowland, through southern Michigan and southeastern Wisconsin, into the northwestern outliers of the calcifics of Minnesota—form the backbone of the great dairying region of the northeastern United States. When manured or fertilized, the soils are well adapted to corn, but the cool climate forces most of the crop to be cut as silage, and sunflowers take its place in the more northerly areas of northwestern Minnesota. Both soil and climate, however, are admirably suited to hay and pasturage crops, especially grass, clover, and alfalfa. These calcifics are relatively shallow, so that the underlying calcareous glacial accumulations are in general near the lower roots—a relation of great importance to calciphilous forage crops. Located within easy access of the Lower Lakes urban district, therefore, the belt has become and will likely remain primarily a dairying region.

The areas of predominantly sandy-textured calcifics of this belt rank somewhat below the average. They are more thoroughly leached and lose fertilizers more rapidly. When carefully handled, they are successfully used as general farming soils. Their feature cash crops are vegetables and fruits, particularly in the vicinity of Lake Michigan, where there is a large acreage of well fertilized orchard and small fruits, vines, and strawberries.

The Ohio-Indiana Corn-Belt-Farming Area. Regarded from the standpoint of the key crop, corn, the calcifics of the western Ohio and northern Indiana district maintain an eastward extension of the Corn Belt, but the cropping system is quite unlike that of the prairyerths, the major Corn Belt soils. The acreages of corn and oats are relatively less important, and two crops of minor importance on

the darker soils—winter wheat and clover—constitute an important part of the crop association.

Unlike the richer prairyerths, the economic management of these poorer soils impels methodical fertilization and a regular crop rotation, and wheat and clover form an integral part of the system. Clover helps to build up the land, while wheat furnishes winter protection in addition to serving as a cash crop. Moreover, in the disposition of forage crops, the area may also be contrasted with the prairyerth economy: dairy rather than beef cattle form the basic stock. Much manure is thus available for the land. The crop diversity is reflective of the great flexibility of these soils.

The Upper Mississippi Upland Stock-Farming Area. As a group, the calcifics of the upper Mississippi uplands extending from Minneapolis to St. Louis are developed on less level topography than that prevailing in the more eastern areas. Many occupy the gentle to moderate slopes below the flatter upland prairyerths with which they are here rather closely associated.

The regional agriculture is also of the Corn Belt type, but systems of stock farming, rather than grain farming, are the more characteristic. The average farm contains much rough and rolling land ill-suited to cultivation, and the soils themselves are sometimes subject to serious erosion. When limed, they are admirably adapted to blue grass, clover, and alfalfa; and the rough, untillable land affords considerable additional pasturage. The southern part of the area has chiefly beef cattle, while the north specializes in dairying and is noted for its cheese and butter factories.

The Kentucky Inner Blue Grass Area. Though famous for its limestone lands, the soils of the Lexington Plain of Kentucky, like all calcifics, are low in carbonates and other solubles and respond to lime and fertilizers. The marked tolerance of blue grass to the moderately acid soils and the fact that land previously in blue grass produces the best quality of Burley tobacco account for the striking agriculture. But tobacco soon depletes the soil, and a long rest in blue grass must follow. Hence, the typical farm carries a large reserve of blue grass pasturing livestock, a limited acreage is annually converted to tobacco, and the balance is used for grain and clover rotation. Under this system and with the soils prevailingly phosphatic practically no fertilizers have to be purchased.

The Nashville Basin Stock-Farming Area. The calcifics of the Nashville Basin are fundamentally like those of the Lexington Plain, but the area also includes a large total acreage of relatively shallow soils, known as glade lands, that support an open growth of cedar and are non-arable, although good for permanent pasture.[3] As in

[3] Professor A. E. Parkins of George Peabody College estimates their aggregate areas as about one quarter of the Basin.

the Lexington Plain blue grass pasture, corn and hay form the framework for the agricultural complex, but tobacco is only of local, yet promising, importance. This, combined with the high percentage of non-plowable pasture and the open winters, has tended to place a much greater emphasis upon livestock.

The Appalachian Valley General and Specialized Farming Areas. The Appalachian limestone valleys, extending from northern New Jersey to central Tennessee, are expanded through a rather wide range of climatic conditions, yet the basic agriculture for the subgroup as a whole is much like that of the Ohio-Indiana Corn-Belt-Farming Area.

Cigar leaf is the well known feature crop of the Lancaster district, but, unlike the Kentucky tobacco area, the soils are heavily manured. Systematically rotated corn, wheat, and clover and the application of manure obtained from feeding beef cattle, rather than blue grass, make up the foundation of the farm management plan.

An unusually large proportion of the Virginia valley is in improved pasture. As in the case of the Kentucky basin, the limestone soils support excellent stands of blue grass. These pastures make a specialty of producing early spring lambs for the June and July markets.

Only a part of the apple crop of the famous Cumberland-Shenandoah-Potomac district is grown on the normal soils of the region. The less mature soils of the hill and mountain slopes with frost immunity are usually the preferred sites. Being less leached of their bases, the soils have a slightly better structure. Furthermore, they carry many chert and shale fragments, the inclusion of which retards erosion and makes them more retentive of moisture and organic matter—two conditions to which apples are especially sensitive.

In the valley of East Tennessee the prevailing soils are either slightly more reddish or are yellowish and slightly more leached and of poorer structure than the northern calcifics. Some contain large quantities of chert. Yet corn, hay, and wheat are still the leading crops, though of poorer quality, and the small Greene County white Burley center stands out as the southern counterpart of the Lancaster tobacco district.

The narrow body of limestone soils developed in the Bedford district of southern Indiana supports a grain and hay agriculture very similar to that of the Appalachian valleys, the well kept apple and peach groves recalling the orchards of the Shenandoah Valley.

Along the eastern Ozark border are belts of chert-free limestone soils also identical with these of the Appalachian valleys. They were among the earliest soils in Missouri to be brought under cultivation, having been occupied by the first band of German Lutherans who settled in the United States. The regional agriculture that has been worked out is in general similar to the rotated grain, hay, and live-

stock régime of the Appalachian valleys. Like all calcifics, they are very responsive to intelligent treatment—a circumstance that is reflected in the flourishing appearance of the area with its large churches and well built houses.

The Ozark Agri-Grazing Area. The cherty, limestone soils of the Ozarks are submature but are included here, as their characteristics are more like those of fully developed soils. There are two varieties. One, prevailing in the east, has yellowish subsoils; its larger percentage of chert has subjected it to a more thorough leaching. It comprises the poorer soils. The other has reddish subsoils and is chiefly important in the western and southern margin.

The proportion of land under cultivation is very low. There is difficulty of access, and the soils are prevailingly stony and occupy rather rolling terrain. With the exception of fruits, the agriculture is chiefly of the subsistence type and is founded upon small acreages and low yields of corn, wheat, and oats. The original timber stand was not very heavy, and the open woods supported a good growth of grasses. Furthermore, when cleared and properly handled, valuable large pastures can easily be established. Stock raising is consequently the natural basic industry, and thousands of cattle and hogs are annually raised with practically no attention.

The excellence of the reddish subsoil variety for fruit has made it the chief commercial soil. It supports the famous apple, strawberry, and grape centers of the southwestern corner. Its superior structure, good internal drainage yet moisture retentiveness, lesser leached condition, and smaller chert content—enough to help check erosion, but not to make manipulation very difficult—comprise its more important horticultural assets.

The Highland Rim Agri-Grazing Area. Pedologically and geographically the Highland Rim is fundamentally similar to the Ozark Hills. The only noteworthy difference is in the higher percentage of the reddish subsoil variety and the relatively greater freedom of most of the soils from chert. Yet the general economic organization is similar to that of the Ozarks and is in a low, if not lower, state of development. The soil supports a fair to good pasturage. In fact, the southern part has an unusual reputation for its mast-fed hogs and sheep, fattened on acorns and nuts with little additional feed. The widespread fruit culture extending from southern Indiana to Tennessee is reminiscent of the Ozarks but is as yet of only limited commercial import. The outstanding commercial center is the elongated tobacco zone northwest of Nashville, developed chiefly on the yellowish subsoil variety. When fertilized, these poor soils have a reputation of producing an especially high quality leaf.

Taken as a whole, the yellowish subsoil calcifics comprise the least desirable soils of the type. Kentucky regards them as "among

the poorest in the state." Owing to lack of glaciation and dating back to an earlier erosion cycle, they are more thoroughly leached than any other subgroup of the type.

The Non-Calcific Type

The non-calcific type is chiefly confined to the eastern half of the gray-brownerth region, where it occurs as relatively small, elongated, and somewhat disconnected bodies.

The type makes a good general farming soil but ranks below the calcifics in structure and in requiring more lime and fertilizers. Unlike the calcifics, therefore, it is marked by a notable percentage of forest, pasture, hay land, and cut-over land. The regional agriculture has become rather closely identified with stock farming, especially of the dairy type, as a large part of the soils is on the outskirts of urban zones.

The Coastal Plain Truck and Fruit Areas. The soils and agriculture of these areas furnish the chief exception to the general utilization of the non-calcifics. The textures are prevailingly sandy. The processes of evolution, however, have endowed the mature soils with slightly heavier-textured or more compacted subsoils and a small percentage of organic matter, making them somewhat more retentive of moisture and fertilizer. Yet they warm up early in spring, as the C horizons provide excellent underdrainage. Nearness to the Boston-to-Baltimore urban region and the ease with which the chemical deficiencies can be corrected have encouraged the development of these soils into the major trucking belt and one of the more important fruit districts of the continent.

In contrast to the sandy outer Coastal Plain, the Inner Lowland of New Jersey and middle and eastern Long Island is characterized by a large development of loams and silt loams, chiefly used for general farming and specializing in dairying or in fruit or potatoes, for which latter crop they are highly prized.

The Eastern Appalachian General Farming and Dairying Areas. Geologically the old hard rocks of the northern Appalachians are strikingly unlike the sedimentaries of the Coastal Plain, but pedologically the normal mature soils of these two provinces are fundamentally alike. All are brownish in color and possess the same basic profile features. The most marked difference is a secondary one, the Appalachian soils being dominantly of finer texture.

This Appalachian group forms a series of elongated, interrupted bodies extending from east-central New York,[4] through the northern section of the Blue Ridge and Piedmont provinces, to the southern section of the Blue Ridge uplands of North Carolina. The

[4] The non-calcifics of this district are derived chiefly from glacial drift composed of slate and shale débris from local rocks. The soils, like those of the Ozarks, are submature.

type topography is sufficiently smooth to permit the development of maturity, though the soils are associated with a large aggregate area of hilly and mountainous land mantled with young soils.

Regarded in their entirety, the soils present a pleasing countryside of general farming and stock raising. Dairying is naturally more important in the north and beef and other stock toward the south or in more dissected areas. The yield of corn, small grains, and hay is lower than that of the calcifics. The pasturage is also inferior to the average of the calcifics, although blue grass will often come in naturally and when limed forms very good pastures. An appreciable area is in woodland. The soils are good fruit producers, but the only outstanding commercial center is the Lower Hudson Valley, where favorable climatic conditions extend for several miles away from the river.

A geographic phenomenon of unusual interest is the production of potatoes in the southern Blue Ridge uplands. For the gray-brownerths as a whole the chief potato centers lie either along the northern or eastern margins, but in North Carolina the Blue Ridge carries both soil and climate into the South. Here potatoes and fruits, chiefly apples of reputed quality, as well as corn, wheat, and clover—all typical gray-brownerth crops—are produced on fertilized clearing in the forest.

The Northwestern Appalachian General Farming and Dairying Areas. The soils of this subgroup form a broken belt on the northwestern border of the Appalachians, extending from south-central New York to northeastern Ohio. Their parent materials were chiefly morainic till composed almost entirely of material derived from light-colored sandstones, conglomerates, and shales. Although of unlike derivation, they differ in no important respect from the eastern Appalachian group.

Lying on the edge of the populous Lake Plains and Cleveland-Pittsburgh urban district, they too, like the northern part of the eastern Appalachian soils, have an understructure of general farming based on moderate yields of corn and hay and specialize in dairying. Some fruit of good quality is also grown, as the uneven surface and good drainage are well adapted to orchards and berries, but, as in the eastern Appalachian district, the industry is chiefly local.

The Immature Gray-Brownerths

As a whole, the immature gray-brownerths have about the same color characteristics as the mature members, although the regional color profile is usually only imperfectly developed. The imperfection is especially evident in soils derived from dense heavy-textured materials of strong color resistant to weathering, such as the reddish

fine-textured soils of the Triassic Lowland. The most significant feature of the immature gray-brownerths is the lack of well defined or fully developed textural, structural, and chemical profiles.

Regarded as a group, the immature gray-brownerths are essentially non-agricultural. Mountain or hill agriculture is of local importance, pastures are widespread, and many slopes are in orchard, yet the regional panorama is one of forests and woodlands. Outside the young flood-plain soils, the Triassic Lowland, and such areas as are smoother or favored by special market relations the cultivated land is almost negligible. This is a matter of relief rather than soil. Occupying slope lands where they are periodically rejuvenated by removal of the upper leached layers, the soils are naturally more fertile than the more productive mature gray-brownerths, but the prevailing topography is usually too rough. When the natural protective covering is removed, erosion is accelerated beyond the natural rate, and the entire surface if not also the underlying earthy materials, unless terraced or otherwise protected, is usually carried away. The fertility of these soils has been an inestimable boon to the mountain farmer who is willing to clear new land every few years and has no regard for the waste land he leaves behind. Corn has done especially well, as the moisture is abundant, and the soils, when first cleared, have a fair supply of organic matter and a rather favorable physical constitution.

The Calcareous Type

For convenience of study, the immature gray-brownerths have been roughly divided into three broad subgroups: a calcareous, an acidic, and a non-acidic type.

Derived from formations high in carbonates, the most important feature of the calcareous type is its limey character. The surface horizon usually has little or no lime, but the subsoil is relatively calcareous. The latter is in reality only the slightly modified C horizon, the true B horizon, where present, being merely in an incipient stage of development. The lime is chiefly inherited from the parent formation; unlike that of the pedocals it is not a product of soil evolution. Pedologically, it is only a temporary attribute, as it is lost with increasing maturity; but from man's standpoint it is a current fact, as the rate of removal is relatively slow.

The Kentucky Outer Blue Grass Area. The belt of immature limestone soils surrounding the Lexington Plain has brown or yellowish brown surface horizons and yellowish plastic calcareous "subsoils." Though predominantly of rather hilly topography, the chief agriculture is an extension of the blue grass-tobacco-cereal association of the Lexington area, since the limey soils are admirably adapted to blue grass. Erosion is necessarily widespread, partly because of

terrain and partly because of the slow absorptivity of the dense "subsoils."

The feature crop occupies the uplands near Cincinnati, where has been created one of the major centers of the lime-loving alfalfa in the East.

The Northern Milk and Cheese Areas. About the head of Green Bay, in central southern Michigan, and in the Lake Champlain and the Upper St. Lawrence lowlands are scattered areas of immature soils derived from calcareous glacial lacustrine deposits. Though similar to the soils of the Outer Blue Grass, the subsoils of the Wisconsin and Michigan areas are reddish, and those of Lake Champlain and the St. Lawrence are drab. The prevailing topography is level to gently undulating; but, since only a short time has elapsed since glaciation, and since the summers are short and the soil materials heavy in texture, the soils have been slow to reach maturity and are locally even imperfectly drained. But the heavy texture and poor drainage, combined with the cool climate, favor the production of hay grasses and feed crops and the establishment of pastures. The Champlain and Michigan areas market fresh milk, but the Green Bay and St. Lawrence areas, with less favorable market relations, have specialized in cheese.

The Acidic Type

The acidic type soils, derived chiefly from formations low in lime or yielding only a small amount of carbonates upon decomposition, are economically the poorest of the immature types. They form the humble farm lands of the Kentucky mountaineers and the rocky hill farms of New England and in general are but ill-adapted to general commercial farming.

Two subtypes may be distinguished, the New England and the Appalachian. The New England subtype includes the younger, more acid soils. So immature is the type that the "subsoils" are as light, if not lighter, textured than the surface horizons. The parent materials comprise the non-calcareous glacial accumulations of New England, the northern Appalachians, and the Lake states. The less youthful character of the Appalachian subtype is evinced in its slightly heavier "subsoils" as compared with the surface horizons. The parent materials were derived from the non-glacial formations of the Appalachian province.

The Lower New England-New York Milk Areas. The agricultural settlement, abandonment, and revival of these soils is a popular geographic theme. In spite of the rather acid character of the subtype, the clearings, like most new forest lands, yielded fair returns until the virgin reserves were expended. Then, with the opening of the dark-colored prairie soils, came abandonment. Unable to wrest

a competitive living from soils that nature had unstintingly strewn with alien boulders and almost exhausted long before his arrival, the more enterprising farmer beat a hasty retreat and did not return until very special economic circumstances invited him. The increased city population, demanding fresh milk, made dairying possible. Most of the crop area is now occupied by feedstuffs. Unfortunately the valuable blue grass is grown here with some difficulty. On the other hand, special crops like truck and apples have succeeded, the Nashoba district of Massachusetts for instance being especially noted for its orchards.

The Upper Lakes Cheese and Butter Areas. A mid-west duplicate of the New England subtype extends as a belt across central Wisconsin and Minnesota. Much of it has but lately passed out of the hands of the lumberman and is still covered with stumps and stones. While adapted, like the eastern subtype, to fair-grade pasture and feed crops, the belt is rather isolated; and general farming, with dairying of local import only, sums up the regional agriculture. The logical commercialized industry, therefore, has been cheese or butter making. Cheese making has made greater gain in a factory way in north-central Wisconsin, while butter making has been more important in the western part of the belt.

The Central Appalachian Agri-Forest Areas. The Appalachian subgroup of acidic immature soils supports only a subsistence agriculture. Rugged topography spells commercial isolation, and the erosive position of most of the soils and their general stony character disqualify them for more than local crops, hay, pasture, forests, or tree crops.

The soils are capable of supporting a rather good growth of blue grass—much better than the New England subtype—and in eastern Ohio the hilly land has for some time maintained an important sheep industry. Yet the soils comprise the largest body of gray-brownerths most economically employed either for timber production or for the tree-crop agriculture so earnestly advocated by Professor J. Russell Smith.[5] Aside from topography and erosivity the soils are naturally adapted to an arboreal cover. Their moderate acidity is tolerable to forest trees of high quality, as the original magnificent stand of timber so eloquently testifies. Furthermore, to the nemoriculturist the very stoniness is a virtue. Stones help hold his soils in place and, being in effect nothing more than giant sand grains, increase the absorptivity of the soils—a matter of prime importance to vigor and density of stand.

It should be borne in mind, however, that the forest formation evolves the poorer soil.[6] If it is to be retained at its highest produc-

[5] J. Russell Smith: Tree Crops, A Permanent Agriculture, New York, 1929.

[6] The philosophy that forests "preserve" soils is chiefly applicable to erosion reduction only. Compare Wolfanger: Major Soil Divisions, pp. 44–45 and 59–60.

tivity permanently and with the minimum of fertilizers, rotations and crop combinations—two-story agriculture, etc.—which employ the most beneficial effects of grasses and legumes, must form an important part of the sylvicultural system.

The only tree-crop agriculture of much present importance in this area is that of the apple and peach belts extending from Pennsylvania into North Carolina along the eastern margin, the position here being most favorable to the eastern markets.

The Triassic Lowland General Farming and Dairying Areas. The reddish Pennsylvania soils of the Triassic Lowland embrace the only large areas of the Appalachian subtype sufficiently level for extensive cultivation. The soils, however, are not very favorably disposed. The A horizons lie almost directly on the incompletely disintegrated and relatively impervious shaly parent formation. While the majority of the soils are loams and silt loams, they are rather acid, are comparatively shallow, and possess poor structures, so that they are rather difficult to manipulate, have poor to medium drainage, and tend to dry out in summer. Periodic liming is essential, organic matter is needed, and fertilizers must be applied. When these corrective are employed and the fields are well tilled and a proper crop rotation is practiced they become quite productive.

But such procedure is practical only under extraordinary social or economic relations. The social element was provided in the first place by large initial settlements of hard-working Germans and Swedes, who practiced general farming. Now dairying is a major source of income, and the soils are gradually becoming more productive. Toward the southern end of this belt, where opportunity for specialized agriculture is more limited, however, the average farmsteads are rather poor in appearance, and land changes hands quite frequently.

The Non-Acidic Type

The non-acidic type of the immature gray-brownerths occupies the upper Ohio Valley extending from southwestern Pennsylvania into northeastern Kentucky. In this district the Appalachian formations are largely composed of a mixture of light-colored non-calcareous and slightly calcareous shales, with occasional thin beds of limestone and thicker beds of non-calcareous sandstones. The soils contain little or no free carbonates either in surface or "subsoil," yet the slight admixture of calcareous materials has served to maintain them in an almost neutral or only very slightly acid state.

The Upper Ohio Sheep Area. The type forms only a single economic area of importance. It is basically a sheep country, the major acreage of the typical farm being in pasture. The soils are admirably suited to blue grass; so much so that, when cleared, blue grass quickly takes

the place of other competing grasses and it is easy to keep the pastures in prime condition. In fact, the soils form the most excellent semi-natural grazing hilly lands of large area in the humid East, and the region has become one of the leading sheep districts of the United States. The fine-wool breeds predominate, although mutton breeds, too, and some cattle are pastured.

The region is also celebrated for its apples, the soil, air, and water-drainage conditions recalling the limestone hills of the Shenandoah Valley.[7]

The Abnormal Gray-Brownerths

The soils of this group are characterized by the possession of one or more properties not possessed by normal mature or immature gray-brownerths. Such features include the presence of hardpan layers, mottled horizons, an unusual accumulation of organic matter, etc. Ordinarily the feature has to be corrected if the soil is to be effectively utilized and crops especially adapted to the peculiarities are grown.

The abnormal gray-brownerths may broadly be divided into two groups, an imperfectly drained and a hardpan type. The imperfectly drained type is usually an immaturely developed, poorly drained, but otherwise normal soil. The hardpan type is also imperfectly drained; but its features are more nearly like those of mature soils, and it is distinguished by its unusually dense subsoil horizons forming hardpans.

The Light-Colored Subtype

There are two subgroups of imperfectly drained soils, light-colored and dark-colored. In general the light-colored subtype occupies depressional areas in which forest associations tolerant of imperfect drainage prevail but so situated that it is subject to alternate wet and dry conditions, i. e., in periods of low rainfall it dries out, and such organic matter as has tended to accumulate is oxidized. Both surface and "subsoils" are typically acid. Owing to their light color the soils are popularly known as "white land" or "slash land." They are obviously the poorer subtypes.

The Central Wisconsin Cheese Areas. The light-colored subtype of central Wisconsin is economically a part of the Upper Lakes Cheese and Butter Belt (p. 288). The cool climate and the ease with which good pasture and feed crops can be obtained have been provocative of dairying. Drainage is unnecessary, except for corn, as excellent pasturage can readily be secured by merely clearing away the underbrush and seeding among the stumps.

[7] The apple has brought such prosperity that one county has erected a monument in its fair grounds to the Rome Beauty, its leading apple.

The Indiana-Ohio Corn-Wheat-Timothy Areas. Lying on the margin of productive farms founded upon normal gray-brownerths, the light-colored subtype of southern Indiana and Ohio has tried to imitate the agriculture of the better soils. In their natural condition, however, the soils are cold and late in spring and dry out in summer, are very acid in reaction, are low in organic matter, and tend to "run together"—conditions ill-suited to corn. Winter wheat does better than corn, and timothy is even more successful, fair crops of good quality being obtained. Except where unusual economic conditions have warranted a heavy expenditure in tiling and fertilization, the general agriculture status of these soils is rather low if not actually below a marginal status.

The Eastern Shore Potato and Strawberry Areas. On the Atlantic Coastal Plain the light-colored subtype is known as "white-oak" or "pipe-clay" land. The largest areas occupy the Eastern Shore peninsula. Much of the land is either in a cut-over state or in low-grade pasture. Because of its poor drainage the soil is not very dependable. Summer crops are affected by excessive rain or drought, and winter crops suffer heaving. Corn is the leading staple, but potatoes and strawberries furnish the money crops. Both crops are tolerant of the moist acid soils, strawberries in particular doing their best where the supply of moisture is plentiful during the growth period.

The Dark-Colored Subtype

This subtype occupies the flat or slightly depressed upland interfluves where, remaining wet through most of the year under natural conditions, much organic matter accumulated in the surface layer giving the soils their dark color. The soils are also endowed with a good crumbly structure and, unlike the light-colored subtypes, are generally alkaline or non-acid in reaction. When artificially drained the soils are highly productive but become more or less specialized crop areas.

The Maumee Corn and Sugar Beet Area. Extending southwestward from Lake Erie is an extensive body of the dark-colored subtype mantling the undissected floor of former Lake Maumee. The early settlers found the area covered with wet-land forest associations. Drained and cleared, the general agriculture has become almost a replica of that practiced on the Corn Belt prairyerths. The major crops are corn and oats, for both of which the soils are admirably adapted, with a cattle industry based upon dairying. Winter wheat is also produced, chiefly a secondary crop, as the wet condition of the soil inclines it towards heaving or the formation of ice.

The specialty crop of the plain is the sugar beet. The crumbly structure of the soils furnishes ample root range, while the alkaline

reaction and rather rich, moist, though not wet, character of the soils provides a satisfactory duplicate of its larger irrigated habitat of the West. While the general climate of the Great Lakes region is favorable to the crop, it is noteworthy that the beet is important chiefly in those districts where soils of this character occur.

The Saginaw Sugar Beet and Bean Areas. The dark-colored soils of the Saginaw Bay district lie in a climatic environment less favorable for grain corn but in an economic environment demanding dairy products. Having a larger acreage of dark-colored soils and much encouraged by legislation, the area has become the leading center of beet production in the East. The area has also developed as a major center of bean production. Though tolerant of many soils, beans do best on warm, well drained, non-acid loams, retentive of moisture and well supplied with lime and organic matter. An added advantage is the dark surface which attracts much heat, a condition to which the bean plant is especially responsive.

The Kankakee Corn-Belt-Farming Areas. When properly drained, the dark-colored soils of the Kankakee district are like the prairyerths in being admirably suited to corn and oats. Their fundamental agriculture has therefore come to be of the genuine western Corn Belt type and is in effect a mere northward extension of the cropping system of the major prairyerth body of central Illinois.

The sandy and less readily drained soils of the region, such as the peats, mucks, and other highly organic soils, are valued for specialized crops. The belt fringing the dune border of Lake Michigan, for instance, has become a trucking district for the Chicago region.

Numerous bodies of the dark-colored subtype, too small to be shown on the accompanying map, are scattered widely through much of the gray-brownerth region. The contrast with the neighboring lighter-colored soils has given rise to the popular designation of "black-and-white land." The agriculture of the soils is generally unique as compared with that of the district at large, as they are prized for particular crops. On the Coastal Plains they are valued for corn, potatoes, strawberries, or tomatoes, the average yields being appreciably higher than on the light-colored imperfectly drained soils. On the Till Plains they are recognized as superior corn and hay soils. In southeastern Wisconsin they produce the largest sugar beet tonnage.

The Hardpan Type

The surface and upper subsoils of this type are much like the corresponding divisions of normal mature soils. The marked difference occurs typically in the lower subsoils, these horizons being tough, dense claypans or hardpans, through which water and roots penetrate with difficulty.

The soils, like the poorly drained type, present unusual problems in utilization. Owing to the almost inaccessible position of the hardpan, the group is much more difficult to amend and yields proportionately less when improved. While tiling is capable of relieving the internal drainage conditions to some extent, there are extensive areas which will not tile and on which it hardly pays to ditch and remove the excess surface water. Furthermore, the moderate to high acidity requires heavy liming.

Although the level topography is alluring to agriculture, the appearance of the average farm does not convey the suggestion of prosperity. Equal effort in labor and materials devoted to normal soils would be far more remunerative. Maladjustments are persistent geographic diseases, however; and only a painful, losing competition will drive such areas into retirement. The recent trend towards dairying on some of these soils has considerable merit, and where this industry has become important it has brought a prosperity that contrasts very strikingly with the low level of the hardpan type at large.

The Claypan Subtype

This subgroup occupies the smooth flat uplands of central Indiana and the lower Ohio Valley. The soils are characterized by tough, gummy, clayey subsoil layers. Although popularly so designated, the layer is not a true hardpan but is more correctly termed claypan. Its formation has generally been ascribed primarily to the presence of an unusual amount of sodium carbonate in the parent formation.

The Ohio Valley Grain and Hay Areas. This division forms a broken belt lying chiefly north of the Ohio River and most extensively developed in southern Illinois. The chief crops are corn, winter wheat, and hay. Lying flat and thus being ideal for machinery, the soils have long been an inducement to grain farming. But their history has been an equally long succession of low yields and not a few near failures. Owing to the sluggish internal as well as external drainage, the favorable spring is a dry one; for otherwise the soil remains cold and wet, planting is projected into early summer, and crops run the risk of early frosts or midsummer desiccation as the heavy claypan yields moisture very slowly.

Early maturing crops which prefer the cool moist weather of early spring for germination or seedling development do better than summer crops; hence winter wheat has done comparatively better than corn. The most successful crops have been redtop and timothy, which are more tolerant of the acid soils as well as preferential to cool moist weather for germination. But increased mechanism is restricting the hay market. Apples and tobacco succeed, but the early apple market which is the chief advantage of the region is limited, and the

expansion of tobacco from its present west Kentucky center to the soils at large does not seem warranted. Tobacco is of the dark export type, and the market for this appears to be waning.

The large number of paint-worn and unpainted farmsteads bespeak the inability of the land to supply surplus funds for maintaining equipment in the same prosperous condition which characterizes the average Middle West farm. The faded, gray soils are depressing. One experiences a sense of relief in leaving the country behind him or even coming on to the slightly darker soils and river bottoms of the area.

The western end of the belt appears to have the poorer soils;[8] "gray silt loam on tight clay" is their apt designation by Illinois pedologists. Here the claypan is so stiff and impervious and the topography so flat over large areas that tile cannot generally be used to improve their drainage, and open ditches are inadequate. Necessarily abandonment is common and increasing. One middle-aged farmer informed the writer that his boyhood school, which some thirty years ago had sixty pupils, now has an enrollment of but sixteen.

The Central Indiana Grain Areas. In central Indiana the leached ashen soils with tough, putty-like subsoil layers are variously known as "crawfishy," "white-flat," and "beech flats." Like the Ohio Valley belt soils, they are ill-adapted to grain farming; yet corn, oats, and wheat form the leading crops, chiefly because they are surrounded by normal calcifics carrying on a system based on these grains. Their continuance is largely due to the fact that the soil has interwoven with it numerous small bodies of the rich, dark-colored imperfectly drained subtype which take over the heavy end of the burden. The pioneers preferred the claypan soil because of its better drainage; but, as cropping depleted the soils and agriculture reached more of a commercial status, the neighboring "black lands" were gradually drained.

The Indurated Hardpan Subtype

The distinguishing feature of these soils is the indurated character of one of their subsoil horizons. In its extreme development the hardpan is quasi-stone, so hard, when dry, that a hammer is sometimes necessary to break through it. The causes producing the condition are not fully known. Some pedologists regard it as due to cementation, others as merely close adherence of the soil materials. Its character does not seem to be the same in the various soils composing the subgroups. Some members of the group have been interpreted as "old" soils.

[8] These soils are covered with prairie grasses but are so light in color and so unlike the prairyerths that it has been deemed preferable to include them with the gray-brownerths.

The soils are poorly drained. Aside from the indurated hardpan, the type topography is flat. The soils are very low in soluble constituents and are moderately to strongly acid. They are the poorest of the abnormal group.

The Chesapeake Bay Subsistence Areas. These soils occupy the narrow flat divides separating the estuaries. Though among the first to be settled in North America, they have suffered repeated abandonment.[9] Lying level and being of prevailingly finer texture than the surrounding sandy types of the Coastal Plain, they have been a constant lure, only to be tilled for a few years and then allowed to revert to forest. Owing to their poor drainage they are cold, wet, and late for corn, while small grains and hay are subject to damage in winter by alternate freezing and thawing of the wet surface.

Except for special cash crops, tiling or open drainage is relatively unprofitable, so that the larger part, where in a state of cultivation at all, is marked by a low subsistence level. The chief cash crop is at present tobacco, but the acreage is small, and the leaf a gummy, heavy export type.

The New York-Ohio General Farming and Dairying Areas. The soils of this district occupy the flattish, undissected glacial uplands of the northern Appalachians extending from western New York to central Ohio. Like the Chesapeake Bay areas, they have suffered extensive abandonment. The regional agriculture has been general farming though the naturally poor condition of the soils, coupled with the northerly climate of much of the belt, is unfavorable to grain corn. The soils, however, are well adapted to hay and pasture grasses, and dairying is becoming more important. In the western part of the area, where the hardpan is less dense, conditions are particularly improved.

The acid nature and lateness of the soils and the cool, moist climate have combined to make this belt the chief buckwheat region of the United States. The crop is valued as a money crop, for feed, as a soil improver, and for its relative indifference to poor soils.

The Highland Rim and Ozark Stock-Farming Areas. Capping the sinuous, ridge-top divides that mark the former level of the Highland Rim and Ozark uplands are extensive remnants of hardpan soils most of which are too narrow to be shown on the accompanying map. Freedom from stone, the parklike character of the natural vegetation, and the level topography were conducive to early occupation; but the old, nature-impoverished soils were unable to carry the burden, and a large part has in recent years been abandoned. The general use of the divides for highways, however, makes the land appear to be less extensively occupied than its condition would warrant,

[9] See the writer's "Abandoned Land in a Region of Land Abandonment," *Econ. Geogr.*, Vol. 7, No. 2, 1931.

as filling stations and lemonade stands are proving more profitable than farming.[10]

The Sand Group

Scattered here and there in the gray-brownerth region are some half dozen areas of predominant sandy soils which show little or no textural difference between soil and subsoil, both being largely composed of rather coarse, loose, dry, light-colored sand. The high permeability of the soils has subjected them to thorough leaching, and they hold fertilizers with difficulty. In general the group is marginal and ought not to be employed in an agricultural capacity. Aside from timber, it is apparent that the soils are best used for specialized cropping only.

The sandy soils of southern New Jersey form one of the largest areas of this group. In their natural state the predominant soils are highly podsolized, nearly white, almost pure quartz sand, with a slight admixture of organic matter in the upper few inches, but almost devoid of soluble nutrients. In a sense they are "old" soils. Their highly unfavorable features have made them almost wholly repellent to utilization in any form. Covered with scrubby forests and confined, in general, to the outer Coastal Plain, they are merely threaded by occasional paved roads seeking outlet to the beach resorts. The chief exception is the belt of sandy soils parallel to the Delaware and in the vicinity of Raritan Bay, where the prevailing soils are brownish loamy sands and truck farming is carried on with a considerable degree of specialization.

The central Wisconsin area is the second largest body of sandy soils. Like the Coastal Plain area a considerable part is wooded or in a state of near abandonment, especially in the western portion. While a low grade of general farming is universal, the region is outstanding in its production of the less critical rye and potato.

Rough Broken Land

Commingled with the soils of the Appalachian Highlands are narrow elongated belts of rough, steep, rocky land unfit for cultivation and principally in forest. Only the larger of such areas are shown on the map.

[10] Personal correspondence, Professor H. H. Krusekopf, Missouri Agricultural Experiment Station.

THE PHYSIOGRAPHIC METHOD OF REPRESENTING SCENERY ON MAPS

Erwin J. Raisz

Columbia University

THERE is one problem in cartography which has not yet been solved to general satisfaction and which is a very important one: the depiction of the scenery of large areas on small-scale maps.

Most of our school maps show contour lines with or without color tints. Excellent as this method is on detailed topographic sheets, where every mountain can be shown individually, it fails when it has to be generalized for a small-scale map of a large area. Nor does the other common method, hachuring, serve better. On topographic sheets it shows the steepness of the surfaces if the Lehmann system is rigorously applied, but in maps of countries and continents the hachure lines deteriorate into "caterpillars."

Contour lines give us at least one important fact; they enable us to read the elevation above sea level. But elevation is only one factor and not the most important. The main effect of altitude is upon the climate, and this can be expressed by direct climatic maps. For the study of settlement, land utilization, or any other aspect of man's occupation of the earth it is more important to have information about the ruggedness, trend, and character of mountains, ridges, plains, plateaus, canyons, and so on—in a word, the physiography of the region.

An Outgrowth of the Block Diagram

Our purpose here is to describe and define more closely a method already in use, what we may call the *physiographic method* of showing scenery. This method is an outgrowth of the block diagram. After several sporadic earlier efforts the method was fully developed by William Morris Davis.[1] Professor Davis has used block diagrams more to illustrate physiographic principles than to represent actual scenery. The later application of this method on a large scale is found in Douglas W. Johnson's "Battlefields of the World War."[2] There the oblique view of the block diagram was applied to the almost

[1] W. M. Davis: Die Erklärende Beschreibung der Landformen, Leipzig and Berlin, 1912; *idem:* Practical Exercises in Physical Geography, Boston, 1908.

[2] D. W. Johnson: Battlefields of the World War, *Amer. Geogr. Soc. Research Ser. No. 3*, New York, 1921. Most of the block diagrams were prepared under the direction of Professor Johnson by A. K. Lobeck, F. K. Morris, and S. H. Knight.

vertical map, only the sections on the front edge reminding us of the block form. Some of these were prepared during the war, as the physiographic method was found most satisfactory for showing broad topographic features for certain military purposes.

FIG. 1—Map of France illustrating the use of physiographic symbols.

Professor A. K. Lobeck's Physiographic Diagram of the United States and the one of Europe do away entirely with the block form, and the physiographic symbols are systematically applied to the vertical map.[3] His book "Block Diagrams"[4] is the most extended treatise on the subject.

It is probable that the mathematically-minded cartographer will abhor this method. It goes back to the primitive conceptions of the early maps, showing mountains obliquely on a map where everything should be seen vertically. We cannot measure off elevation

[3] A. K. Lobeck: Physiographic Diagram of the United States, Chicago, 1921; *idem:* Physiographic Diagram of Europe, Madison, Wis., 1923.

[4] A. K. Lobeck: Block Diagrams, New York, 1924.

or the angle of slope. Nevertheless, this method is based on as firm a scientific principle as a contour or hachure map: the underlying science is not mathematics but physiography.

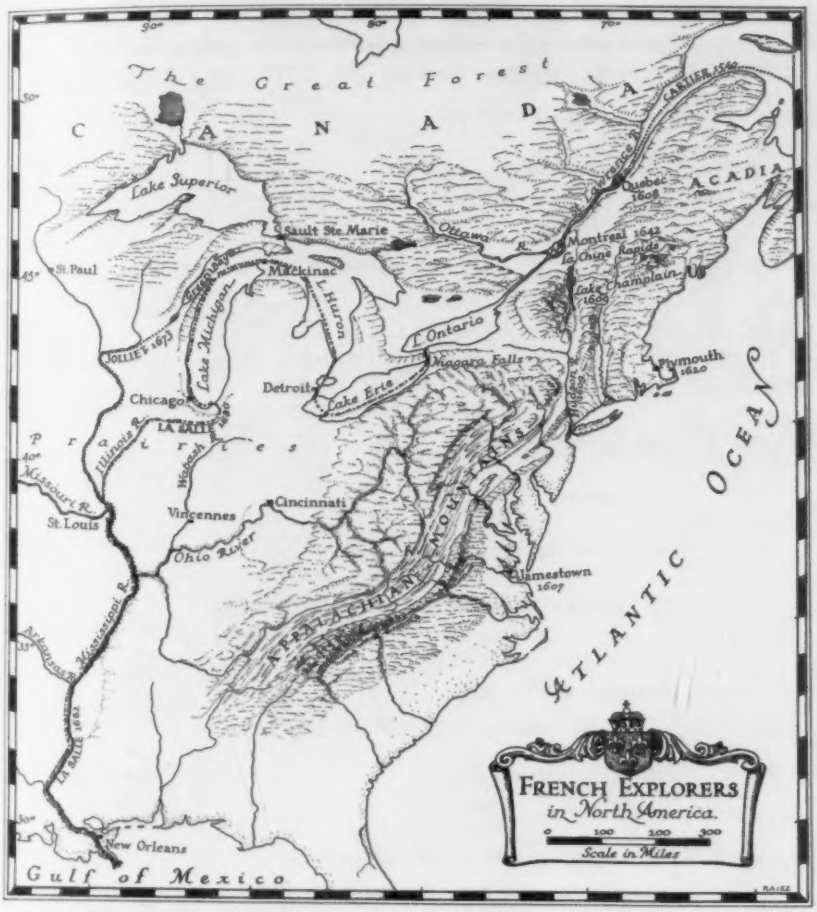


FIG. 2—Physiographic method of showing scenery applied in a simplified form for a historical map.

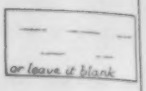
A SET OF SYMBOLS

If we regard the physiographic map as a *systematic application of a set of symbols* instead of a bird's-eye view of a region, we do not violate cartographic principles even though the symbols are derived from oblique views instead of vertical views. It may be observed that our present swamp symbols are derived from a side view of water plants.

The following table represents an effort of the author to classify the earth's surface into types and, from Davis, Lobeck, Morris, Cotton, de Martonne, and other masters of this art, to select the best

TABLE OF PHYSIOGRAPHIC SYMBOLS

1. PLAINS if no distinction is made



Plains offer an excellent opportunity to give additional important information as the TYPES OF VEGETATION

a) sand + gravel plain

b) semiarid "

c) grassland "

d) savannah

e) forest

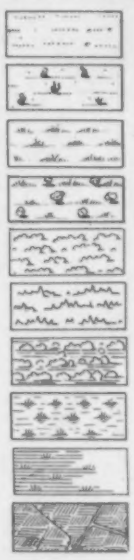
f) needle forest

g) forest swamp

h) swamp

i) tidal marsh

j) cultivated land

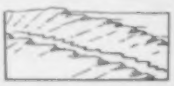


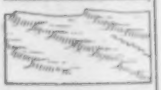
2. Coastal plain *(as Eastern N.J.)*

3. Flood plain *(Mississippi valley)*

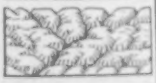
4. Alluvial fans, Conoplain *(Southern California)*

5. Cuesta land *(Paris basin)*





6. Plateau, maturely dissected, in humid regions
(Allegheny Plateau)



7. Plateau, subdued, in humid regions *(Eastern Ohio)*

8. Plateau, young in arid regions. (Canyon land)
(Grand Canyon)

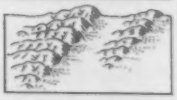
9. Plateau with advanced dissection in arid regions (Badlands) *(South Dakota)*

10. Plateau with more advanced dissection in arid regions (Mesaland) *(Raton Mesa region)*

11. Folded mountains (peneplaned and redissected) *(Newer Appalachians)*

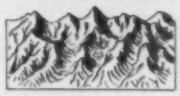
12. Dome mountains " " "
(Black Hills, S.D.)

13. Block mountains *(Great Basin)*



14. Complex mountains, high *(Big Smoky Range)*

15. " " " glaciated (Alpine mts)
(Grand Teton)



16. " " medium *(Adirondacks)*

17. " " low (Matureland)
(S.E. New England)

18. " " rejuvenated *(Klamath Mts)*

19. Peneplane *(Finland)*

20. Peneplane rejuvenated *(Piedmont)*

21. Lava plateau, young *(Snake R. Plateau)*

22. " " dissected *(Columbia Plateau)*

23. Volcanoes *(Java)*

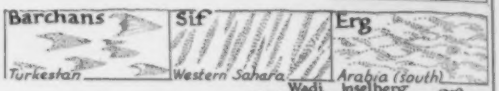
24. Limestone region, low, with sinkholes (Kentucky)

25. " " high, maturely dissected (Karst region) (Dalmatia)

26. " " tropical (Magotes) (Cuba)

27. Coral reefs (Bahamas)

28. Sand dunes



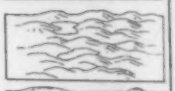
29. Desert of gravel (Serir) Northern Arabia

30. " " deflated stone surfaces (Hamada) (Hamada el Homra, Tripoli)

31. " " clay (Takyr) (Turkestan)

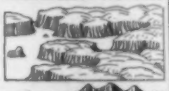
32. Loess region (North China)

33. Glacial moraine, kames, (Long Island)



34. Drumlin region (Boston)

35. Fiords (Norway)



36. Glaciers (Mt Mc Kinley)

37. Continental ice sheet (Greenland)

38. Shoreline of sand or gravel (New Jersey)

39. " cliffed (California)

40. Elevated shorelines + terraces (L. Bonneville, Utah)

symbols for the types, keeping in mind that the good symbol is that which can be read without an explanation.

The existing conventional symbols for roads, rivers, cities, etc., can be used without change in the physiographic maps. The symbols shown should be regarded as examples of means of handling the different types of topography. There are many combinations and transitions possible. The slightly glaciated Rocky Mountains will come between the symbols proposed for glaciated and unglaciated high mountains. The author is fully aware that this table is far from complete and that the symbols proposed are not the only ones that may be satisfactory.

For many purposes a simplified method with less differentiation can be used, as shown in Figure 2, a historical map. But even here care is taken that such important features as the Piedmont, the Older Appalachians, the Great Valley, the Ridge and Valley region, and the Appalachian Plateau should be distinctly separated. The trend and character of these features were of primary importance in warfare, settlement, and land utilization.

Application of the Method

A disadvantage of the physiographic method is that the symbols used are derived from oblique views and therefore the perspective has to be drawn out and the back slopes are not easy to draw. Again, the method gives no information about the elevation above sea level. If colors are used, this can be overcome by combining the physiographic map with altitude tints. Otherwise, frequent figures of elevation may help.

On the other hand and in addition to the basic importance of the type of information yielded by the physiographic method, the map appeals immediately to the average man. It suggests actual country and enables him to see the land instead of reading an abstract location diagram. It works on the imagination. What this means can be best appreciated by teachers.

Furthermore, this type of map is adapted for representation of regions where only reconnaissance surveys have been made. It can be reproduced as a line cut, black on white, without the addition of half-tones or colors.

Finally, it may be said that to produce a physiographic map requires not only the best knowledge of the physiography of the region in question but also a certain ability in drawing. The importance of the latter, however, should not be exaggerated. Almost every student in the author's class in cartography was able to draw satisfactory mountains after a little practice. It is easier and more natural than to draw contours or hachures.

The lack of detailed physiographic maps from which information can be taken is a more serious question. Very little has yet been done in this field. The United States and Europe have been worked out by Professor A. K. Lobeck. For Asia we expect soon to have the map of Professor F. K. Morris. New Zealand has been worked out by C. A. Cotton (not yet published), and Cuba by the author.[5] Notable work is in progress in Canada and Australia, but for Latin America and Africa the work still has to be done. To prepare the detailed physiographic map of the world seems to be a most important project for physiographers at the present time.

[5] E. J. Raisz: Diagrama fisiografico de Cuba, Havana, 1929.

TWENTY-SEVENTH ANNUAL MEETING OF THE ASSOCIATION OF AMERICAN GEOGRAPHERS

The Association of American Geographers met at Worcester, Mass., on December 29, 30, and 31, 1930, for its twenty-seventh annual meeting. The sessions were held in the School of Geography building of Clark University, with Professor A. E. Parkins, of the George Peabody College for Teachers, Nashville, Tenn., President of the Association for 1930, in the chair. On December 30 the members of the Association and others in attendance were guests of the faculty of the School of Geography at luncheon.

As a compliment to Miss Ellen Churchill Semple, who is slowly recovering from a long and grave illness, an exhibit had been arranged dealing with John Filson's early map of her native state. Photostat copies of eleven different versions were shown of his " . . . Map of Kentucke," 1784–1794, including American, French, and English editions, in the Library of Congress. Miss Semple had prepared for the meeting a paper on "Domestic and Municipal Waterworks in Ancient Mediterranean Lands: An Adjustment to Geographic Conditions," which was read for her.

Of a total of 46 papers read, 17 of which were "introduced," 9 dealt with physiography and 6 with water resources, the two topics to which half-day sessions were specially devoted. The selection of physiography was a happy one after the extreme swing of the pendulum toward human geography.

Physiographic Papers

Douglas W. Johnson spoke on "Shore Platforms of the Pacific and Their Significance," including among his illustrations examples from Hawaii, New Zealand, and Japan. In the use of submerged platforms for purposes of correlation, in the study of world-wide changes of sea level, he warned against the temptation of correlating platforms of the same level but really of different date. Francis P. Shepard (introduced) of the University of Illinois discussed "Continental Shelf Glacial Troughs." In "The Importance of Solifluction" W. E. Ekblaw held that many terraces in glaciated north temperate lands are due to solifluction.

The remainder of the physiographic papers were regional in character. A. P. Brigham, in "Glacial Problems in Central New York," reported on field studies extending intermittently over many years and relating especially to the behavior of the Pleistocene ice sheet south of Utica and its southward discharge into the valleys draining into the Susquehanna. F. E. Matthes, in "How the Mississippi Came to Break Through Crowley's Ridge," presented a new explanation of the present location of the river at the head of the Mississippi Embayment. He showed that the waters of the ancient Mississippi, then flowing southwest through the Advance Lowland from Cape Girardeau, Mo., had broken through Crowley's Ridge in a southeasterly direction by means of a number of gaps, one of them nine miles wide, which then gradually closed up as a result of silting, thus leaving the river in its present position. The volume of water necessary to create this outpouring was accounted for by the discharge at the edge of the Pre-Wisconsin ice sheet. G. E. Condra's paper (read by N. A. Bengtson) set forth "The Present Interpretation of the Development of the Platte River Bottom Lands in Nebraska" below the junction of the North Platte and the South Platte, hinging on the basic difference between the upper pre-Pleistocene and the lower post-Kansan segments. N. A. Bengtson

spoke on "The Physiography of the Southern Maracaibo Lowland of Venezuela," and Wallace B. Atwood (introduced) dealt with peneplains of the Causses and Cévennes of southern France. A paper by George B. Cressey (introduced) of Clark University gave a good general survey of the distribution and classification of loess in China and of the latest theories concerning its origin and regional derivation.

Climatology

Alexander McAdie spoke on "The Commercial Importance of Fog Control," illustrating his remarks with laboratory experiments; and R. DeC. Ward gave an excellent brief review of the present outlook for "The Literature of Climatology" in all its branches. P. E. Church (introduced) discussed "The Temperatures of New England" on the basis of original isotherm maps; Edith M. Fitton (introduced) in "Soil Temperatures in the United States" emphasized the small number of stations at which observations have been made; K. B. Allen (introduced) spoke on "Tornado Frequencies in the United States and Their Relation to Storm Tracks" and A. K. Botts (introduced) dealt with "The Rainfall of El Salvador." C. F. Brooks presented "Some New Climatic Maps of the United States" consisting of the maps Professor Ward and he have prepared for the American section of the new edition of Hann's "Klimatologie" being issued under the editorship of Köppen and Geiger. W. H. Hobbs spoke on the "Meteorological Work in Greenland" being carried out by the Wegener, the British Arctic Air Route, and the University of Michigan Greenland expeditions. The outstanding contribution in this section was the paper by Richard Joel Russell on "Dry Climate Boundaries" in the United States. Expanding his previous study of the climates of California (*Univ. of California Publs. in Geogr.*, Vol. 2, 1926) to include the whole arid west, he subjected Köppen's climatic values and boundaries (version of 1928) to a critical review. The result is a new detailed and authoritative map of the dry climates of the United States (text and map since published in *Univ. of California Publs., in Geogr.*, Vol. 5, No. 1, 1931).

Population Studies

Six papers were devoted to population problems in one aspect or another. Mark Jefferson, in "The Geographical Distribution of Great Cities," presented a masterly analysis of the distribution of the larger cities throughout the world and their significance. This paper will be printed in the July number of the *Geographical Review*. W. L. G. Joerg in "A Note on the Numerical Distribution of the Population of the World According to Climate," selecting Griffith Taylor's major economic regions (*Geogr. Rev.*, Vol. 12, 1922, p. 378) as the simplest for an experimental calculation, gave present population figures for each of these 75 regions, which are essentially climatic provinces. Lester Klimm (introduced) of the University of Pennsylvania discussed "The Geographic Basis of Population Changes in Three Massachusetts Counties." J. F. Bogardus (introduced) of the University of Pennsylvania, under the title "Changes in the Size and Activities of the Population of the Netherlands," showed how that country had solved the problems of population increase by rapid industrialization. C. E. Batschelet (introduced), Geographer of the Bureau of the Census, spoke on some geographical aspects of the census enumeration. Roland M. Harper's paper on "Geographical Variations in Longevity," relating to various sections of the United States, was read by title.

Urban and Rural Field Studies

The intensive field studies of urban and rural areas were represented by eight papers. C. C. Colby analyzed the general principles governing the "Centrifugal and Centripetal Forces in Urban Geography." Wellington D. Jones reported on the field mapping of certain residential areas of metropolitan Chicago, the classi-

fication of the types mapped being based on physical form and not on function. Lewis F. Thomas traced "The Sequence Occupance of the Cheltenham District of St. Louis." M. F. Burrill (introduced) reported on "A Field Study of Montreal." D. S. Whittlesey described a case of "The Urbanization of a Farm Village," showing how Ellsworth, Me., in its inevitable abandonment of agriculture became a summer-resort base, with interests primarily urban. Stanley D. Dodge (introduced) of the University of Michigan spoke on "Bennington, Vermont: A Geographical Study of Urban Growth." Robert S. Platt's "Pirovano: Items in the Argentine Pattern of Terrene Occupancy" described an *estancia* studied on his recent South American trip.

Regional Geography

Five papers dealt with regional topics. Among them is included President Parkins' address, made at the annual dinner on December 30. This gave an excellent and sympathetic picture of the geographical and social conditions of "The Antebellum South." In a synthetic study called "The Nordic Region" Professor C. B. Fawcett of the University of London, who had been visiting professor at Clark University, argued for the geographical unity of the lands tributary to the North and Baltic Seas. W. E. Ekblaw gave a vivid personal account of "Russia Today" on the basis of a visit during the last International Congress of Soil Science. The paper on "The Mechanization of Agriculture in the U. S. S. R." by Frances M. Earle (introduced) was based mainly on Soviet figures. Ellsworth Huntington's "A Cross Section of Northern Africa" constituted a geographer's travel notes on a trip from the Nile Delta to the equatorial lakes. Eugene Van Cleef's paper on "The Finns of Ohio" may also be mentioned here.

Economic Geography

The second topic selected for special discussion at the meeting, namely water resources, comprised most of the papers that fall under the domain of economic geography. A. E. Parkins provided a general survey of "The Water Power of the Southern Appalachian Region," and F. E. Williams discussed "Hydro-Electric Development in Pennsylvania." In discussing the "Water Supply in Large Cities of the United States" Robert M. Brown first took up the cases of Los Angeles and New York as representing the contrasting problems of arid and humid areas and then dealt with certain general questions. A paper by Julia M. Shipman (introduced) of Mount Holyoke College gave an excellent insight into the physical factors affecting the distribution of water through an urban area as illustrated by Worcester, Mass. Eugene Van Cleef gave a "Report on a Proposed Canal Connecting Lake Erie with the Ohio River."

In addition to the symposium on water resources, of which Miss Semple's paper, mentioned above, was a part, several other papers bore on the economic aspect of geography. Langdon White (introduced) of Randolph-Macon Woman's College discussed "The Iron and Steel Industry of Wheeling, W. Va." Helen M. Strong returned to the theme she has made peculiarly her own in "How Business Is Using and Might Use the Science of Geography." The paper by E. G. Mears (introduced) of Stanford University was an important contribution to the question of the relationship between economics and geography. He discussed the mutual profit to each science of the contributions of the other, citing, among those of value to the geographer, the statistical correlations of the economist, and, among those of value to the economist, the regional concept. Professor A. P. Brigham's general address at the annual dinner on "The Centenary of the Royal Geographical Society," at which he represented the American Geographical Society (see *Geogr. Rev.*, Jan., 1931, pp. 142–145), although not economic, bears a relation to the previous paper in that it dealt with one aspect of the history of the development of our science.

AMERICAN GEOGRAPHICAL SOCIETY

The December Meeting. The regular monthly meeting of the American Geographical Society was held on December 18, 1930, at the Engineering Societies' Building, 29 West 39th Street, President Finley in the chair. The Reverend Father Bernard R. Hubbard, S. J., head of the department of geology of the University of Santa Clara, Cal., addressed the Society on the "Volcanic Wonderlands of the Alaska Peninsula." With the aid of still and motion pictures Father Hubbard described his explorations in the Katmai National Monument and the Valley of Ten Thousand Smokes, the great crater of Aniakchak where his party lived for two weeks, and the crater glacier of Veniaminof Volcano.

The January Meeting. The Annual Meeting of the Society was held on January 20, 1930, at the Engineering Societies' Building, 29 West 39th Street, President Finley presiding. After the reading of the Annual Report (printed below) and the election of officers for 1931 an illustrated address was given by Captain Robert A. Bartlett on "The Lost Eskimo." This described the work of the "Bartlett East Greenland Expedition" of 1930 for study of the remains of the vanished Eskimo tribes of the east coast of Greenland north of Scoresby Sound and for the collection of natural history specimens. An account of the expedition will appear in a forthcoming number of the *Geographical Review*.

The February Meeting and Award of the David Livingstone Centenary Medal for 1931 to Captain Riiser-Larsen. The regular monthly meeting of the Society was held on February 24, 1931, at the Engineering Societies' Building, 29 West 39th Street, President Finley in the chair.

Announcement was made of the award of the David Livingstone Centenary Medal for 1931 to Captain Hjalmar Riiser-Larsen for his work in the Antarctic on the *Norvegia* expedition in 1929–1930. On this occasion the *Norvegia*, in prosecution of Consul Lars Christensen's plans of scientific investigations in the Antarctic in conjunction with whaling operations, carried out explorations in the sector between Enderby Land and the Weddell Sea. Queen Maud Land was discovered to the west of Enderby Land, and Crown Princess Martha Land was discovered on the eastern margin of Weddell Sea. The results of this eminently successful expedition were described by the leader in the *Geographical Review* for October, 1930. Further contributions are to be expected from Captain Riiser-Larsen, for he has returned to the Antarctic, joining the *Norvegia* in February, to take charge of the latter part of this season's work.

Captain Riiser-Larsen has also participated in two notable Arctic expeditions—the Amundsen-Ellsworth Polar Flight of 1925 and the flight of the *Norge* across the Polar Sea in 1926, proving himself a most skillful navigator of both airplane and airship.

After the announcement of the medal award the Society was addressed by Mr. Carveth Wells on "The Mountains of the Moon" (Ruwenzori Range), whither Mr. Wells led the Massee Expedition in 1928 under the auspices of the Geographic Society of Chicago. This interesting lecture was illustrated by brilliant still and motion pictures.

Elections to Fellowship. At the December, January, and February meetings of the Society, President Finley presiding, there were presented with the approval of

the Council the names of 124 candidates who were duly elected as Fellows of the Society.

Recent Publications

The Vinland Voyages. "The Vinland Voyages" by Matthias Thórdarson, Director of the National Museum of Iceland, is a contribution to the study of the problem of the Norse discovery of America. It discusses the documentary sources, the sagas in Hauk's Book and the Flatey Book; deals briefly with the voyages of Leif Ericsson and of his brother Thorstein; and treats at length of the expedition of Thorfinn Karlsefni, undertaken with colonization in view. Director Thórdarson's original Icelandic text has been translated by Mrs. Thorstina Jackson Walters, and Vilhjalmur Stefansson, dwelling on "the striking upheaval of folk energy known as the Viking Age," has written an account of "the steps by which the discoverers reached the vantage points of Iceland and Greenland" to furnish a background for the story. The volume has been edited by Halldór Hermannsson, Professor of Scandinavian Languages and Curator of the Fiske Icelandic Collection at Cornell University, and appropriately bears the imprint 1930, the millennial year of the foundation of the Parliament of Iceland.

ANNUAL REPORT OF THE COUNCIL

New York, January 20, 1931

To the Fellows of the Society:

It will be seen from the following summary report that the activities of the Society as a research institution are of a quite varied character. Our quarterly journal, the *Geographical Review*, represents the active edge of geographical experience. A resumé of the principal features of the volumes for 1930 is placed at the beginning of this report.

The Geographical Review

In continuation of the Society's program of polar research are articles dealing with the Antarctic discoveries of the 1929–1930 season. Sir Hubert Wilkins describes his further explorations in the American Antarctic Archipelago and the area westward. That part of Sir Hubert's discoveries relating to Charcot Island is discussed by Dr. Charcot, who compares conditions in the region in 1910 and 1930 and presents a hitherto unpublished sketch of Charcot Island as seen by him in 1910 from the crow's nest of his ship fifty miles away. Sir Douglas Mawson and Captain Riiser Larsen have filled in no little of the longest stretch of Antarctica's uncharted coast line between Gaussberg and Coats Land. The reports of all three expeditions are accompanied by separate maps in color.

In the field of Arctic exploration the Society has been privileged to publish an account of the remarkable journeys in Baffin Island made by the Canadian naturalist, J. Dewey Soper, and of Therkel Mathiassen's expedition of 1929 under the auspices of the Ministerial Commission for Scientific Investigations in Greenland, which is of particular interest for the light it sheds on contact between Eskimos and Norsemen in medieval times. A sub-Arctic land is the scene of E. P. Wheeler's "Journeys about Nain: Winter Hunting with the Labrador Eskimo." His map of the vicinity of Nain, in color and on a scale of 1:500,000, is a useful contribution to a poorly charted and difficult coast. Harold A. Innis of the University of Toronto, in a paper on Canada's new sub-Arctic outlet, the Hudson Bay Railway, describes the construction of the line in some of its new features and analyzes its traffic possibilities. On the opposite shores of the Canadian realm Marius Barbeau of the National Museum of Canada traces the growth of an aboriginal art in a well illustrated article on the totem poles of the Nass and Skeena rivers.

The archeological reconnaissance by air in Central America undertaken by Colonel Charles A. Lindbergh and the Carnegie Institution of Washington is described by A. V. Kidder and Oliver Ricketson, of the Carnegie Institution, and illustrated with photographs by Mrs. Lindbergh and Mr. Ricketson. The conclusion is reached that "an intensive survey of the region [the Maya area] would amply justify its cost." The growth and importance of civil aviation in Latin America is discussed by H. Case Willcox. At home the progress made in the meteorological service for airways is treated by W. R. Gregg of the United States Weather Bureau.

Exploration in South America is represented by the reports on the Cerro Duida Region of Venezuela by G. H. H. Tate and C. B. Hitchcock and on Roraima by G. H. H. Tate. The expedition to Cerro Duida spent three months on the top of this mountain, heretofore believed to be impregnable. They found its flora and fauna to have affinities with that of Roraima 400 miles eastward, suggesting an interesting problem in distribution. From exploration one turns to a social problem in one of the most advanced countries of South America: the treatment of the agrarian problem in Chile is described by G. M. McBride as a factor making for stability.

The policy of the Society to foster research on all the frontiers of geographical knowledge is illustrated by articles on such diverse topics as geophysical methods of prospecting, the new means of "seeing into the crust of the earth," by Donald Barton and E. Buhler Summers, and the history of population and settlement in Eurasia by A. P. Usher, a contribution to the investigation of the process of settlement of interest to the student of economics because of the light such study sheds on "the nature of social adaptation to resources."

The *Geographical Review* pays particular attention to effective graphical presentation. Among papers noteworthy in this respect are Carl R. Raswan's "Tribal Areas and Migration Lines of the North Arabian Bedouins," "Land Utilization Maps of Manchuria," by Nobuo Murakoshi and Glenn T. Trewartha, and "A Population Map of Central Oklahoma for 1920," by C. J. Bollinger. Reference may also be made to the series of text maps accompanying L. Dudley Stamp's article on Burma.

The October number of the *Geographical Review* regretfully records the death of Fridtjof Nansen: tribute to him as a man and an explorer is paid by Dr. Finley, President of the Society.

Altogether there were published in the *Geographical Review* for 1930 41 leading articles, 64 items of geographical record, and 68 reviews. In addition to the many text maps there were 7 insert maps.

We are indebted to a Fellow of the Society, Robert Lee Forrest, for the contribution to more than 200 foreign scholars of copies of the *Geographical Review* for 1929 and 1930. Every institution that distributes a journal is aware of the difficult conditions under which scholarly work was resumed in Europe after the World War and the great handicap under which professors and graduate students carry on their work. In view of these conditions Mr. Forrest's action is most praiseworthy, and the Society hopes that other Fellows may wish to continue the support which Mr. Forrest has provided for a two-year period, now ended.

Books and Maps

As part of its program of polar research the Society issued two publications in this field during the past year. "Brief History of Polar Exploration Since the Introduction of Flying" (second edition, revised and enlarged), by W. L. G. Joerg, affords a concise survey of Arctic and Antarctic expeditions since the airplane and airship have come into extensive use. There are also sections on air navigation in the polar regions and on recent developments in political sovereignty. The work is accompanied by a new physical map of the Arctic and a bathymetric map of the Antarctic from original sources, both on the same scale.

Prior to the return of the expedition the Society published a 70-page booklet entitled "The Work of the Byrd Antarctic Expedition, 1928–1930" giving an account of the various flights and sledge trips on the basis of the radio despatches received day by day by *The New York Times*, some of the outstanding despatches being reproduced in facsimile by arrangement with that newspaper. This booklet was distributed free of charge to 20,000 public schools and libraries in the United States, a distribution on a scale never before attempted by a private institution and with results most gratifying to educational leaders. It will be recalled that a distribution of a wall map of Antarctica to schools and colleges was made by the Society in 1929 to illustrate recent geographical discoveries.

"Peru from the Air," by Lieutenant George R. Johnson, contains a series of 142 aerial photographs of Peru fully described by legends and notes and accompanied by an introductory article on the landscape of Peru illustrated with numerous maps and sketches. The photographs were chosen from a large collection taken by the author during 1928 and 1929 while serving as Chief Photographer of the Peruvian Naval Air Service and were so selected and arranged for publication as to present a representative cross section of the topography and life of the country.

In recognition of the celebration at Reykjavik in 1930 of the millennial of the founding of the Parliament of Iceland, the Society has published "The Vinland Voyages," by Matthias Thórdarson, the Director of the National Museum of Iceland. Mrs. Thorstina Jackson Walters translated the text from the original Icelandic, Vilhjalmur Stefansson has written the introduction, and Professor Halldór Hermannsson, Curator of the Fiske Icelandic Collection at Cornell, has edited the book. A short and readable account, the book is a contribution of modern scholarship to an absorbing historical problem.

Millionth Map of Hispanic America

During 1930, seven sheets of the Millionth Map were fair-drawn, bringing the total number of sheets on which the drafting work is completed to fifty-two. Of these, thirty-two sheets have been published, eight others are in proof, and the lithographic plates on five others are now being prepared. Nine sheets were compiled during the year, and the work of assembling compilation material for and the partial compilation of a large number of additional sheets is advanced to a point where it is estimated that the Society's work on the map is now more than two-thirds completed.

Much new compilation material has been assembled, especially for Mexico, Venezuela, Colombia, and Brazil. This department has also assisted in preparing the plans for several exploring expeditions to various parts of Hispanic America, the survey work resulting therefrom to be placed at the disposal of the Society for incorporation in the Millionth Map.

The first volume of the Catalogue of Maps of Hispanic America, an enterprise that has engaged the Society at intervals during the past eight years, has now been published but will not be distributed until all four volumes of the catalogue have been completed. The second volume is now being printed, and the third is almost ready for the printer.

Atlas of the Historical Geography of the United States

Early in 1929 an agreement was concluded between the Society and the Carnegie Institution of Washington under the terms of which the Society has undertaken the editing of the "Atlas of the Historical Geography of the United States," by Dr. C. O. Paullin. Work upon this great atlas was begun in 1912. Most of the maps were compiled especially for the "Atlas" on the basis of original research carried out by Dr. Paullin or under his direction at the Department of Historical Research of

the Carnegie Institution. The following topics are illustrated: the physical background of American history, the development of the cartography of the United States, Indian tribes and relations of white men with the Indians, explorers' routes, and the history of land systems, boundaries, population, colleges, churches, presidential elections, votes in Congress, industries, commerce, distribution of wealth, growth of cities, and military campaigns. The "Atlas" will be published jointly by the Carnegie Institution of Washington and the Society, probably early in 1932.

Air Map Research

In October, 1929, a conference was held at the American Geographical Society to discuss a research program for the purpose of improving the standard of maps to be used by airmen while flying. Representatives from various government departments and air corporations attended the meeting, at which it was decided that the Society should attack the problem by first compiling a map and printing it as a basis for criticism and suggestions.

The area selected for experimental work was the region between Cleveland and Pittsburgh. A map of it is now being compiled, and it is hoped to be able to publish it before the end of the ensuing year. A second conference will then be called, and the experimental map and the conclusions first arrived at will be submitted for further criticism. Practical experience is sought to determine in general what features should be shown on the map. Numerous flights have been made, mostly in the area of the map but including one from San Francisco to Chicago. Mr. G. A. Thorne has taken a keen interest in the research and has very kindly coöperated to the extent of giving the use of his own plane and his services as pilot, in addition to advice and counsel in the planning of the scheme as a whole. To determine the best method of representing on paper the information it is required to show, a small specimen map was first printed. In the light of the experience thus gained a new system of representation has been planned.

Pioneer Settlement

Reference was made in the last annual report to support by the Social Science Research Council of the Society's program of research in the undeveloped but available lands that constitute the so-called "pioneer belts" of the world. The first major project is Canadian in scope and personnel. The field work of the Canadian Pioneer Problems Committee was widely extended during the past year, the Canadian scholars associated in it have given repeated assurances of its value, and the prospect is most promising for the completion of the work in 1932 or 1933. The manuscript for the volume of general papers on pioneer settlement is now complete and will be published by the Society in 1931. A separate introductory volume entitled "The Pioneer Fringe" will appear simultaneously. During the past summer field studies were made by the Society in the Far West, the first result being published early in 1931 under the title "Jordan Country." On all sides there come increasing evidences of the soundness of the conception of concerted work on the types and problems of settlement now developing on the frontiers of the habitable lands.

Special Regional Studies

As announced in the report for 1929, the Society is conducting a regional study of New England as an initial step in a series of population studies of the United States. The coöperation of twenty-nine economists, sociologists, historians, geographers, and men of affairs has been secured toward the preparation of a book, to be published early in 1932, in which the problems of New England will be discussed from many angles. Some of the objectives of the project are outlined in a paper entitled "New England" which appeared in the *Geographical Review* for July, 1929.

In preparation for a volume on the physical history of the Connecticut Valley since the retreat of the last ice sheet, Mr. Richard J. Lougee has continued his intensive studies of lake and river terraces, varved clays, delta deposits, and related glacial phenomena. Heretofore the technique of study of glacial features in New England has lacked critical elements now available through the studies of Antevs on annual clay layers and of other students on terrace phenomena—a subject never developed in a comprehensive way, however admirable the local studies have been.

By a coöperative arrangement with the Carnegie Institution and private donors, the work of Mr. Godfrey Sykes on the delta of the Colorado River was continued during 1930 with promising results. One of the objects is to secure a record of the channel changes and of the cutting and building processes before these are obscured by the work of the reclamation companies now active in the region.

A similar plan involving the Carnegie Institution and Columbia University has provided the means for concerted work on marine terraces of the Atlantic and Gulf coasts that will be brought to realization in 1931 under the supervision of Professor D. W. Johnson of Columbia. A report on the work will be submitted at the next International Geographical Congress at Paris in September, 1931. Thanks to the generosity of Count Costantini, who provided the Society with initial support for the project, substantial new studies are now in progress that are expected to help clear up a problem now in an extremely confused state.

The School of Surveying

During the year fourteen students have taken courses at the School. In general, the instruction consisted of a combined course in reconnaissance surveying and field astronomy. A short course was given in the theory of aerial surveying, and several students paid special attention to navigation.

Numerous requests are received for technical information on surveying methods and instruments and in mathematical geography. Over forty books have been added to the School's technical library, and the classified technical index of books and articles is proving of considerable use both to staff and students.

Complete lists were published of all stars in the American, British, and French nautical almanacs crossing the 60° altitude circle for latitudes 60° N. to 60° S. The book containing them is the culmination of seven years of labor on the part of members of the staff of the School and places the equal-altitude method of star observation for longitude and latitude determination on a thoroughly practical basis for the first time.

Honors

Presentation of the Charles P. Daly Gold Medal to Joseph Burr Tyrrell, distinguished Canadian geologist and geographer, was made at a luncheon at the Rideau Club, Ottawa, on January 17, 1930, with the officers and directors of the newly formed Canadian Geographical Society in attendance (*Geogr. Rev.*, Vol. 20, 1930, p. 312).

At the monthly meeting of February 25, 1930, of the American Geographical Society, The Cullum Geographical Medal was presented to Dr. Curtis Fletcher Marbut, Chief of the Division of Soil Surveys of the United States Department of Agriculture. At the same meeting the Charles P. Daly Medal was presented to Nelson Horatio Darton of the United States Geological Survey. The presentations were made by Honorary President Greenough.

The David Livingstone Centenary Medal was presented to Dr. José M. Sobral, Director-General of the Dirección de Minas, Geología e Hidrología, Ministerio de Agricultura, Buenos Aires, through the kind offices of the American Ambassador, in a ceremony duly noted in the *Geographical Review* for January, 1931.

The Charles P. Daly Medal for 1930 has been awarded to Dr. Lauge Koch of Copenhagen for his explorations in northern and eastern Greenland and his interpretations of the physical geography of that region.

At the regular monthly meeting of the Council and Fellows on November 20, 1930, the David Livingstone Centenary Medal for 1930 was presented to Dr. Laurence M. Gould, Second-in-Command of the Byrd Antarctic Expedition, for his work in Antarctica.

Gifts

Mr. Henry Thayer of Boston has repeatedly added, in the past, to the Society's collection of photographs, and he has again generously given a set of views of Central America.

Mr. Lars Christensen of Sandefjord, Norway, who has large whaling interests in the Antarctic, has thoughtfully presented the Society with three albums of photographs that include views of the whaling museum at Sandefjord, of the whaling industry, and of Bouvet Island and Peter I Island.

The Museum of the American Indian, Heye Foundation, has been good enough to present the Society with a set of glass negatives of scenes in Palestine.

Special mention should be made of the gift to the Society, by the Touring Club Italiano, of the "Atlante Internazionale," one of the finest general atlases now available.

Through the kindness of Mr. Joseph J. Heard of Brookline, Mass., and of Captain Sir Hubert Wilkins, to whom it was first sent, the Society has received a transcript from the journal of Mrs. John J. Heard of a voyage with her husband, Captain John Jay Heard of the bark *Oriental*, Boston to Melbourne, 1853, and a transcript from the log book of the same vessel relating to the discovery of Heard Island in the Antarctic.

Representation at Scientific Meetings

Senator Kean and Senator Walcott, Councilors, represented the Society at the April, 1930, meeting (Fiftieth Anniversary) of the American Society of Mechanical Engineers at Washington, D. C. Professor Albert Perry Brigham of Colgate University and Mr. H. Stuart Hotchkiss, Councilor, were the delegates of the Society at the Centenary celebration of the Royal Geographical Society at London in October, 1930; and Professor Brigham's report on the meeting was published in the January, 1931, number of the *Geographical Review*. On behalf of the Society, Messrs. W. L. G. Joerg and J. K. Wright attended the December meeting of the Association of American Geographers at Worcester, Mass.; and, by invitation, Dr. Isaiah Bowman presented a paper on "Polar Exploration" before the Berkeley, California, meeting of the National Academy of Sciences on September 18, 1930 (*Science*, Vol. 72, 1930, pp. 439–449).

Library

Additions to the library during the year comprised 686 books, 1371 pamphlets, 1134 volumes of periodicals, 3547 maps, and 47 atlases. The collection now consists of 93,990 volumes of books and periodicals, 14,117 pamphlets, 79,727 maps, and 1583 atlases. Notable gifts and other acquisitions were: 877 pamphlets from the Explorers Club of New York; Exquemelin's "Bucaniers of America," 1684, from Mr. C. A. D. Burk; Liberian government publications from Mr. John W. Vandercook; Guthrie's "New System of Modern Geography," 1794, and Carey's "General Atlas," 1800, from Mrs. A. B. Collins; H. W. Scott's "History of the Oregon Country"; Semenov's "Geographical and Statistical Dictionary of the Russian Empire"; "History of the Russian Geographical Society"; sets of the topographic maps of Belgium on the scale 1:40,000 and of Morocco, 1:50,000; the first volume of an industrial atlas of Russia

to be complete in five volumes; a climatic atlas of White Ruthenia; and a political atlas of Russia.

Cards representing over 7000 items were entered in the special research catalogue (see Annual Report of the Council for 1926).

The library coöperated in the preparation of the now completed "Manhattan Maps—a Co-operative List" issued by the New York Public Library and also contributed material to the *Bibliographie Géographique*, the *Union List of Serials*, and the *List of Serial Publications of Foreign Governments*.

Lecture Program

The speakers and titles upon the Society's lecture program during the past year are as follows: Mr. F. A. Mitchell-Hedges, "Land of Wonder and Fear"; Mr. R. H. Sargent, "Alaskan Glaciers from the Air"; Mrs. Thorstina Jackson Walters, "Iceland: The Kingdom of a Hundred Thousand"; Captain Sir Hubert Wilkins, "Further Antarctic Explorations"; Dr. Laurence M. Gould, "Antarctic Explorations"; "Bernard R. Hubbard, S.J., "Volcanic Wonderlands of the Alaska Peninsula."

Fellows

The number of Fellows at the close of the year was 5902, of whom 391 are Life Fellows. In addition there were 4 Honorary Members and 41 Corresponding Members.

Report of the Treasurer for 1930

The Council has received a report from the Treasurer giving a summary of the income and expenses of the Society, and the accounts of the Society have been audited by certified accountants whose report is on file at the office of the Society.

Philip W. Henry, *Chairman*

REPORT OF THE SPECIAL COMMITTEE

New York, January 15, 1931

The committee appointed at the meeting of the Council held on December 18, 1930, to nominate officers for the vacancies to occur in the Council in January, 1930, beg to nominate the following named gentlemen for the offices designated and move that the same be approved and presented to the Society for election at its meeting to be held on January 20, 1931.

		Terms to expire in
President	John H. Finley	January, 1932
Vice-President	W. Redmond Cross	January, 1934
Recording Secretary	Hamilton Fish Kean	January, 1934
Treasurer	Henry Parish	January, 1932
Councilors	Philip A. Carroll Wesley C. Mitchell Archer M. Huntington Charles R. Crane	January, 1934

Paul Tuckerman
Roland L. Redmond
H. Stuart Hotchkiss } *Committee*

GEOGRAPHICAL RECORD

NORTH AMERICA

Mexican Immigration to the United States. Although there is no quota limit upon the number of Mexicans who may come into the United States, there are various obstacles in the way of unlimited legal entries. As a consequence many a peon slips over the border—swims the Rio Grande, perhaps—unnoticed and uncounted by official eyes; and the official statistics fall far short of measuring the great tide of Mexican immigration (G. E. Hoover: Our Mexican Immigrants, *Foreign Affairs*, Vol. 8, 1929, pp. 99–107). A rough idea of its magnitude may, perhaps, be gained from figures quoted by the Mexican Department of Migration, figures that are certainly more accurate than the corresponding ones published by our government. The former show that 769,113 Mexicans entered the United States and 1,085,222 returned to Mexico during the years 1910–1928. It would be absurd to suppose, however, that more Mexicans actually went home than left their country. The figures merely indicate that more of them registered on entering than on departing from Mexico.

It is also impossible to say how many Mexicans are permanent residents of the United States. According to our census there were 103,393 Mexicans here in 1900, 219,802 in 1910, and 478,383 in 1920; but we do not know what proportions of these totals represent temporary immigrants who happened to be in the United States at the moments when the counts were made.

Although the completion of railroad communications between the two countries gave the Mexican peon a means of reaching the United States, it cannot be regarded as other than a secondary cause of his migration northward. Since 1910 Mexico for years at a time has been in a state of political and economic chaos. In the words of M. S. Handman the peon has been torn "away from his moorings and . . . [sent] sprawling and dazed all over the land, hungry and afraid and in search of shelter and food" (Economic Reasons for the Coming of the Mexican Immigrant, *Amer. Journ. of Sociology*, Vol. 35, 1929–1930, pp. 601–611; reference on p. 605). Each successive political upset has been accompanied by a flood tide of emigration, each period of calm by an ebb (see the graphs illustrating this in Manuel Gamio's pamphlet entitled "Quantitative Estimate: Sources and Distribution of Mexican Immigration into the United States," Mexico, 1930).

During precisely these years of disorder in Mexico there has arisen in the United States a new demand for labor in regions readily accessible to the Mexican and in occupations suited to him, a demand stimulated by the closing of our doors against the European during and since the war. As Handman points out, it has arisen most markedly in the truck gardening industry, which has grown to great proportions in recent years. The departure of the negro to the cities and to the North has also left a place for the Mexican in the cottonfields of Texas. With the inflation of agricultural land values successful farming in many parts of our country has become dependent upon a plentiful supply of cheap unskilled field hands. And, though his wages are low by American standards, the Mexican laborer in the United States, according to Gamio, can earn on an average six times as much as his brother in Mexico. No wonder he has come, bringing with him not only plant pests and diseases of men and animals (Hoover, *op. cit.*, p. 106) but also a crop of thorny social problems.

The Social Science Research Council has interested itself in these problems. With the Mexican Government it has lent support to a comprehensive investigation under

the direction of Dr. Manuel Gamio (Manuel Gamio: Mexican Immigration to the United States: A Study of Human Migration and Adjustment, Chicago, 1930; see also Gamio's pamphlet cited above and summary of his main conclusions by Robert Redfield in *Amer. Journ. of Sociology*, Vol. 35, 1929–1930, pp. 433–438). Among the many interesting things that Gamio and his assistants have disclosed are new facts showing whence the Mexicans come and where they go. Recourse was had to records of money orders sent from the United States to Mexico. From these it was possible to plot graphs showing the yearly trends of migration between 1920 and 1928 and dot maps showing by states the number of drafts issued in the United States and paid in Mexico. The maps make it clear that the low-lying coastal regions of Mexico, including Yucatan, have yielded very few immigrants. More have come from the states along the northern border. The source of the great majority, however, is the western portion of the high central plateau, particularly Guanajuato (24.27 per cent), Michoacan (16.42 per cent), and Jalisco (16.23 per cent). This is a backward and priest-ridden part of Mexico, a region particularly hard-hit by the politico-economic crises of late years. The Indians who originally settled here—and whose descendants are now flooding our southwestern and middle-western states in what Hoover (*op. cit.*) calls "the greatest Indian migration of all time"—were of a relatively low cultural level, distinctly below that of the Aztecs, Toltecs, and Mayas (Gamio, Mexican Immigration, p. 61).

In spite of the fact that our Census Bureau classifies Mexicans as "white" and our Bureau of Immigration upholds this fiction in admitting them, most of them are either full-blooded Indians or mestizos in whose veins there is not much Spanish blood. When the Mexican settles down in an American community he is not regarded as a white man. Besides the handicaps of ignorance and poverty against which every newly arrived immigrant folk has had to contend, against him is the additional handicap of racial prejudice almost as pronounced as that prevailing against the negro. Dwelling apart in communities or "colonies," often segregated in the schools, the Mexican has almost no social relations with his American neighbors, whose attitude toward him is much like that of the Southerners toward the colored man. No one who reads Dr. Paul S. Taylor's detailed studies of Mexicans in California and Colorado can fail to be impressed by the depth of this social gap (P. S. Taylor: Mexican Labor in the United States: Imperial Valley, *Univ. of California Publs. in Economics*, Vol. 6, pp. 1–94, Berkeley, 1928; Mexican Labor in the United States: Valley of the South Platte, Colorado, *ibid.*, Vol. 6, pp. 95–235, 1929).

Most far-sighted Americans, therefore, will probably agree with Dr. Gamio that the permanent establishment of Mexican immigrants in this country is not at all to be desired. Not only does it create a new race problem here, but it means, perhaps, "a step backward in the progress of Mexico and a definite loss in useful energy for the development of [that] country" (Gamio, Mexican Immigration, p. 176). On the other hand Gamio believes that much may be said in favor of allowing temporary immigration to continue, provided means may be devised to enforce the immigrant's return. Temporary immigration brings to the United States much-needed labor at the same time that it permits the Mexicans to make money and send it home to their native villages. Certainly if immigration from Mexico were suddenly stopped the consequences would be disastrous.

Manhattan Maps. In 1901 the New York Public Library issued a "Check List of Maps and Atlases Relating to the City of New York in the New York Public Library" (*Bull. New York Public Library*, Vol. 5, 1901, pp. 60–73). It has now issued a much more ambitious work "Manhattan Maps—a Co-operative List," edited by D. C. Haskell, New York, 1931. The present work originated with the late P. L. Phillips' manuscript "List of Maps and Views of New York City in the Library of Congress, 1639–1865." Inasmuch as it was decided to incorporate with the

holdings of the Library of Congress those of the New York Public Library, the New York Historical Society, the American Geographical Society, and certain city departments, it was found impracticable to use Mr. Phillips' list; so that the work as it now stands is a new compilation. It "aims to enter maps of Manhattan Island and those maps of New York and vicinity which show the island in relation to the surrounding country. It does not attempt to include maps of the harbor as such, nor, in general, maps of small sections of the island." There is an index of cartographers, engravers, printers, and publishers, and also an index of subjects. The 1994 items listed range from 1600 to 1930 and are arranged chronologically by the date depicted. The earliest original copy of a map in the collections is the Library of Congress' copy of the Manatus map first reproduced in I. N. Phelps Stokes: Iconography of Manhattan Island, 6 vols., Robert H. Dodd, New York, 1915–1928.

Primarily a bibliography of books, Otto Hufeland's "A Check List of Books, Maps, Pictures, and Other Printed Matter relating to the Counties of Westchester and Bronx" (New York, 1929) also contains titles of maps.

A companion work to the Phillips list of maps of New York is "A Descriptive List of Maps and Views of Philadelphia in the Library of Congress, 1683–1865," by P. Lee Phillips. It is issued, by permission of the Library of Congress, as Special Publication Number Two of the Geographical Society of Philadelphia, 1926.

Pennsylvania Caves. An account of eleven "commercial" caves—that is, of caves prepared for visitors by construction of paths and installation of electric lights—and of twenty undeveloped caves in the limestones of Pennsylvania has lately been prepared by Ralph W. Stone and published by the Topographic and Geologic Survey of that state (Bulletin G 3, Harrisburg, 1930). The caves are usually found in moderately inclined strata. Those commercially developed vary in straight-line length from 250 to 2000 feet and in length of path traversed from 600 to 4000 feet. Outline maps show most of these to be relatively simple linear passages, but a few have passages and chambers of network pattern. Half-tone illustrations are largely devoted to dripstones; the form of the non-masked rock walls, although sometimes highly significant as to process of cave production, is less often shown. A brief discussion of origin minimizes erosion by underground streams and ascribes excavation to solution by circulating carbonated waters close to water-table level. Solution by ground water below the water table is not considered. Dripstone deposition by evaporation of percolating vadose water is thought to begin "when a cave has been formed and solution has been stopped because the circulating water occupies only the lower part of the cavity or has been diverted elsewhere." The large monetary value of a good cave may be inferred from the fact that Indian Echo cave, near Harrisburg, was visited by nearly 40,000 persons in the second half of 1929. Kennedy cave, on the Schuylkill near Philadelphia, formerly famous for its fossil mammals (54 species, of which 41 are extinct), has been almost destroyed by quarrying.

W. M. DAVIS

SOUTH AMERICA

Winds at Chuquicamata, Chile. During the four years ended August 31, 1929, the Chile Exploration Company operated a wind observation station at its copper mining plant, Chuquicamata, Chile. The purpose of this station was to ascertain sufficient of wind directions and velocities to guide the company in locating its new concentration plant where it would not cause noxious fume nuisances. Chuquicamata occupies a midway position between the Pacific Ocean and the watershed barrier forming the Western Cordillera of the Andes: and at its elevation of 9200 feet it also stands midway between sea level and the dominant peaks of this range.

Although the four-year period included two summer seasons of abnormal rainfall, little variation is noted in the wind observations from year to year. An arrow representing the resultant of all winds would point from the northwest, and the prevailing winds blow from this direction at all seasons of the year. Figure 1 shows that 84 per cent of the wind miles and 78 per cent of the wind time occurred between north and south-southwest. The greater portion of wind mileage occurs during the winter season, May to October, in consequence of the storms that blow continuously for three days or longer at this time. The strongest winds occur generally during the six-hour period from noon to 6 p. m. (Fig. 2), and here is no important seasonal variation, the afternoon breeze being fully as strong in summer as in winter. However, the afternoon wind is the only strong wind during the summer months. Much of the night wind (the 6 p. m. to 6 a. m. periods) comes from the north, owing to the groups of hills that tower to 5000 feet above Chuquicamata in this direction. It is a typical mountain-valley wind, the *serrano* or mountaineer. The small easterly component is accounted for mostly during the summer months, November to April, and in large part during the 6 a. m. to noon period at this season. Graphs and summary tables of the data are on file at the American Geographical Society.

W. E. RUDOLPH

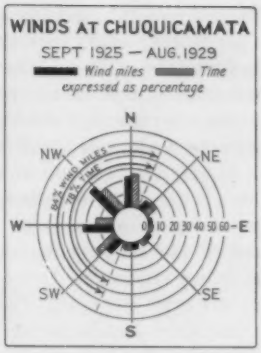


FIG. 1

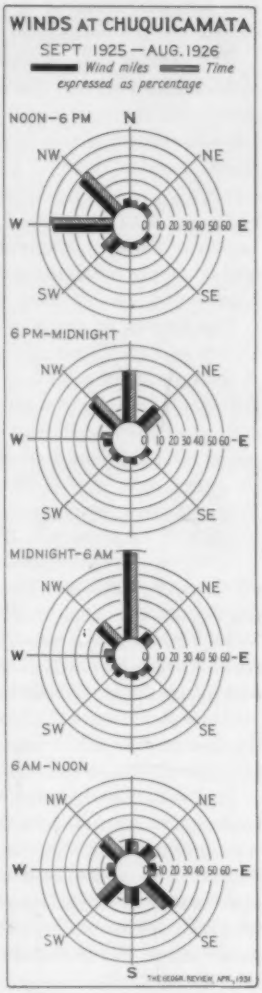


FIG. 2

AFRICA

The Region of the Great Shotts and the Question of Atlantis. The region of the great shotts and the basin of the lower Igharghar is the subject of a dissertation, "Grundlagen und Versuch einer landschaftskundlichen Gliederung der nördlichen algerischen Sahara," by Lucie Raehder (*Aus dem Archiv der Deutschen Seewarte*, Vol. 48, No. 2, Hamburg, 1929). The picture is well chosen, the subject well defined. The author has had at her disposition manuscript notes taken by Professor Siegfried Passarge during his travels in 1906–1907, and his authority gives importance to the brochure. The work, however, is archaic in its documentation. Thus, apropos of the artesian waters in the oasis of the Wadi R'ir, the author says: "There are many water-bearing layers superimposed to the depth of 75 meters, two in particular, according to Georges Rolland: the one in the Turonian under the Senonian marls, and the other deeper under the Cenomanian marls." But Rolland's study, interesting for its day, was published in 1894, 36 years ago. Numerous borings have given us much more information; and Savornin, ignored by Dr. Raehder, is the present authority. The deepest known water-bearing layer is at 190 meters (Mraier; in April, 1924, it furnished 40,000

liters a minute). All the water-bearing layers occur in continental deposits of post-Eocene age, which here are of a proved thickness of 300 meters. The list of maps is likewise peculiar. The author gravely cites the Atlas Pellet, 30 years old and completely superseded, and ignores the topographic maps, almost completed, on scales of 1:100,000; 1:200,000; and 1:500,000. In fact the picture of the region reflects our knowledge of thirty years ago.

North Africa is one of the countries where direct communication from man to man is peculiarly necessary, for here the slow pace of bibliography cannot keep step with rapid development. My own "Aménagement du Sahara," 1929, is already out of date on some details. In the study of the Sahara international collaboration still has far to go. But a passage of Dr. Raehder's dissertation illustrates a step in the right direction. Passarge had read with intense interest the researches of his pupil Paul Borchardt on the region of the great shotts (Auffindung von Platos Atlantis, *Berliner Lokal-Anzeiger*, April 13, 1928). Borchardt's investigations had to do with Plato's Atlantis, or more precisely the proto-historic Tartessus, a site heretofore placed in the vicinity of the Strait of Gibraltar. Dr. Borchardt places Atlantis in the basin of the great shotts and makes Tartessus a port near Gabes.

The central idea is that the region of the great shotts has changed within the historical period, that the isthmus of Gabes did not exist, and that the Mediterranean penetrated more or less deeply into the present-day closed basin of the shotts. Dr. Raehder treats of this briefly in a section in which the documentation, as in other cases, is out of date. "To the south of Beled Ahmar a wooden boat has been unearthed . . . and at Nefta on the Jerid Shott (250 km. from the coast) an ancient galley . . . ruins covered by sand . . . concealing more than 100 oases on the border of Jerid." Impressive details drawn from Tissot, who wrote fifty years ago and is merely reporting native talk. All subsequent efforts to confirm these legends have failed, and Tunisia now has its topographic map on the scale of 1:100,000.

The field of research proposed by Dr. Borchardt is the village of Udref between Gabes and the Shott el Jerid. I have seen it and failed to be impressed; but that is the opinion of a layman. Nor do all the German archeologists follow Borchardt. Adolf Schulten, for instance, continues his investigations at the mouth of the Guadalquivir. Professor Passarge, at Borchardt's request, undertook a short trip thither. He gives an account of it in "Ergebnisse einer Studienreise nach Südtunesien im Jahre 1923" (*Mitt. Geogr. Gesell. in Hamburg*, Vol. 41, 1930, pp. 96–122). It is very detailed, very suggestive, and of great interest to Tunisian geologists. But in spite of his good will towards Borchardt he clearly rejects the Udref hypothesis.

However, German scholars have not renounced search for Tartessus in the basin of the great shotts. Dr. Albert Herrmann, in an article entitled "Forschungen am Schott el-Djerid und ihre Bedeutung für Platons Atlantis" (*Petermanns Mitt.*, Vol. 76, 1930, pp. 169–174), departing from Borchardt's identification at Udref, seeks Tartessus much farther in the interior, on the border of the Shott el Jerid, at a place named Rhelissia. Dr. Herrmann also is not quite complete in his documentation. He does not utilize Paul Penet's work "L'hydraulique agricole dans la Tunisie méridionale" (1913), a monograph on the Shott el Jerid by a man who has long administered the region.

The difficulty remains the same whether it is Udref or Rhelissia. Since the thirteenth century before the Christian era the isthmus of Gabes has been in existence with a width of 80 kilometers and an altitude of 39 meters above sea level: before this time, so close to our own, there was in place of the isthmus an arm of the sea, of which all geological search has failed to find a trace! One wishes that the German investigators would transfer their attention to the Ahaggar, which offers alluring perspectives to the archeologist. Since 1912 a number of curious discoveries have been made there, largely by chance—the owl-head *bétyles* of Tabelbalet, the ram's head statue of Tamentit, the bull's head of Tazruk, the furnishings of the tomb

of Tin Hinan (compare *Geogr. Rev.*, Vol. 16, 1926, pp. 383–384), the unpublished ethnographic results of Conrad Kilian's last expedition, another bull's head found some few months ago. Messrs. Borchardt and Herrmann should extend thither the field of their hypotheses and researches. I will not promise them the solution of Atlantis, but assuredly they would find something worth while. A German expedition to the Ahaggar would not only be interesting, it might stimulate a spirit of emulation in the Algerian authorities!

E. F. GAUTIER

ASIA

Geomorphology of Western Tibet. The inferences, based on more or less empirical descriptions by its explorers, that explain Tibet as a former well worn down, submountainous lower land, broadly uplifted with local displacements and actively trenched on its southern and northern margins by outflowing rivers, now find good warrant as well as instructive elaboration in a study by H. de Terra of Yale University, who in company with Emil Trinkler and W. Bosshard crossed the western part of that lofty region in 1927–1928 (Geomorphologische Studien zwischen oberem Industal und südlichem Tarimbecken, *Zeitschr. für Geomorphologie*, Vol. 5, 1930, pp. 79–131).

The enclosed areas of the highland, at altitudes approaching 5000 meters, are occupied by broad forms of low relief containing numerous salt lakes on their flat floors. They are surmounted by residual ridges and are separated by several lofty ranges bearing local glaciers. Here the short streams follow broad valleys heading normally in the mountains and opening on the salt-lake plains. Terraces indicate that the lakes have shrunk from a former greater size.

The rivers of the non-enclosed highlands have their sources in broad valleys but soon descend into valleys more and more sharply and deeply incised as they escape northward or southward through bordering ranges, to which they are thought to be antecedent. Tertiary continental deposits, lying unconformably on the low-relief surface of the highland basins, were apparently deposited when increasing aridity or deformation weakened transportation. They have been much uplifted with some faulting and are now more or less dissected.

Even the highest ranges give indications of owing their sharply carved forms to revived erosion acting on forms of moderate relief, much uplifted. However, no single widespread peneplain of an earlier time is inferred; but rather several peneplains of different dates and areas now standing at various altitudes and diversely dissected.

W. M. DAVIS

Sir Aurel Stein's "Innermost Asia" and Supposed Climatic Changes in Central Asia. During the years 1913–1916 Sir Aurel Stein carried out his third expedition in Central Asia. The scientific results were published in 1928 by the Clarendon Press, Oxford, in four volumes under the title "Innermost Asia." This work is uniform in format, binding, and general internal arrangement with the two other major publications of the same author—"Ancient Khotan" (2 vols., Oxford, 1907), covering the expedition of 1900–1901, and "Serindia" (5 vols., Oxford, 1921; reviewed in *Geogr. Rev.*, Vol. 12, 1922, pp. 660–662), on that of 1906–1907. The eleven volumes together are a monumental landmark in the literature of modern archeology and geographical exploration. Stein's investigations of ancient sites, together with those of von Le Coq, Grünwedel, and Pelliot, have opened new and wide horizons to the student of Asiatic history (see Albert von Le Coq: Buried Treasures of Chinese Turkestan, London, 1928; bibliography). The topographical surveys of the Indian surveyors under Stein's direction have given us accurate maps of huge areas previously imperfectly known or even wholly unknown.

The first two volumes of "Innermost Asia" consist of text; the third of superb reproductions of photographs and drawings of the archeological relics collected and of plans of sites explored; and the fourth of maps. The maps, which incorporate the topographic results of all three expeditions, were first published by the Indian Government in 1923 (see "Memoir on Maps of Chinese Turkistan and Kansu from the Surveys Made During Sir Aurel Stein's Explorations . . ." *Records of the Survey of India*, Vol. 17, Dehra Dun, 1923; reviewed in *Geogr. Rev.*, Vol. 14, 1924, pp. 652–653).

The text is in the main a detailed narrative of the expedition. Nearly every chapter concludes with a descriptive list of the archeological objects found at the sites described in the preceding pages. As appendixes a series of notes and lists by other scholars relate to manuscripts, inscriptions, coins, ceramics, mineralogical specimens, and physical anthropology. The narrative itself is broken by long digressions on the history of places and regions visited and by frequent comments on matters of physical and historical geography. It is, perhaps, to be regretted that no broad, connected historico-geographical survey is attempted. Such a synthetic view, however, is given in a paper read by Stein before the Royal Geographical Society ("Innermost Asia: Its Geography as a Factor in History," *Geogr. Journ.*, Vol. 65, 1925, pp. 377–403 and 473–501).

Leaving Kashmir in July, 1913, Stein crossed the Hindu Kush by a route that for part of the way had not been previously taken by a European traveler. Kashgar was the first important stopping place in Chinese Turkestan. Thence, turning eastward, Stein reached the Lop Nor region by way of the Yarkand and Khotan valleys, Khotan, and the southeastern fringes of the Takla-makan. Northwestern Kansu and southwestern Mongolia were penetrated before the return journey was begun in the summer of 1914. The first part of the return lay across the desolate and unexplored Pei Shan wastes to Hami and Barköl on the Dzungarian borders. Thence Turfan was reached, where most of the winter of 1914–1915 was spent and an immense harvest of archeological relics gathered. In the summer and autumn of 1915 further explorations were made in the Russian Pamirs and upper Oxus region, and during the ensuing winter Seistan was visited. In all over eleven thousand miles were traversed.

Such, in barest outline, was Stein's route. A few words may be added on certain points of exceptional interest.

Near Lop Nor, among relics found in the grave pits of "the walled Chinese station of Loulan" (dating from about the time of Christ), there was disclosed "a mass of remarkable textiles, including fine specimens of the earliest known Chinese silks as well as woolen tapestries showing clear evidence of Hellenistic influence." From this vicinity an old trade route ran eastward across the desert to the settled frontiers of China. This route is mentioned in the early Chinese records, and Stein followed its course. That he was actually on it was dramatically confirmed by the finding of a large number of coins and arrowheads scattered along the surface of the ground. They had doubtless been "dropped by some convoy of Han times coming from the side of China and carrying stores for troops." In the borderlands between Kansu, Chinese Turkestan, and Mongolia the line of fortifications constructed by the ancient Chinese as a defensive system against the desert tribes was revisited. Stein calls these works the Chinese *Limes*, likening them to the Roman *Limes* of Germany and Britain. They constitute the westernmost extremity of the Great Wall, which prior to Stein's second expedition had not been known to reach so far west within 250 miles (F. G. Clapp: Along and Across the Great Wall of China, *Geogr. Rev.*, Vol. 9, 1920, p. 242).

In southwestern Mongolia near the point where the Etsin Gol loses itself in the desert Stein explored the ruins of Khara Khoto, "the black town," a medieval city which he identified with Marco Polo's "City of Etzina." This identification may

be questioned, since Khara Khoto is actually mentioned by name and described in a manuscript of the *Milione* first brought to light by L. F. Benedetto in his critical edition of Marco Polo's travels ("Marco Polo, il Milione," Florence, 1928, pp. clxix, clxx, 46 (footnote)).

Possibly the most remarkable of all the places visited by Stein was Turfan. The lowest parts of the Turfan depression are more than 800 feet below the sea level, a circumstance that accounts for the relatively warm climate. Although Turfan is surrounded by some of the bleakest tracts in Asia and lies farther north than Boston, two crops may be grown there yearly on well manured soil, and "cotton as well as fruits can be produced in abundance." Cultivation, however, depends entirely upon irrigation, which draws largely upon ground water tapped by artificial subterranean canals. The Turfan depression has probably supported a dense population since very early times. More recent details are given by R. C. F. Schomberg in papers on "The Turfan Depression" (*Journ. Central Asian Soc.*, Vol. 15, 1928, pp. 301–304) and "The Aridity of the Turfan Area" (*Geogr. Journ.*, Vol. 72, 1928, pp. 357–359).

The Tarim basin as a whole is classic ground to students of the fascinating problem of climatic changes. It was largely upon his observations there that Dr. Ellsworth Huntington based his theory of desiccation as an explanation of the great folk wanderings of the Asiatic tribes in the Middle Ages ("The Pulse of Asia," Boston, 1907). However, in regard to this problem the archeological and physiographic evidence gathered by Stein and more recent travelers is both puzzling and conflicting. Stein asserts that "had not such conditions of extreme aridity [as those which exist now] already prevailed in ancient times, it would be impossible to account for the survival in almost perfect preservation of a multitude of objects, very perishable by nature, in places so exposed as refuse heaps outside houses" (*Geogr. Journ.*, Vol. 65, 1925, p. 487). And yet "there is abundant and convergent antiquarian evidence that the rivers of the Tarim basin carried a greater volume of water during the historical periods with which we are concerned than they do now" ("Innermost Asia," p. 80). These two theories do not seem to hang together, and Stein is aware of the difficulty of reconciling them. The second conclusion, that there has been an actual shrinkage of the rivers entering the Tarim basin, is supported by Dr. Emil Trinkler, who explored parts of the Takla-makan in 1927–1928 ("Geographical and Archaeological Explorations in the Takla-Makan Desert of Chinese Turkestan," *Journ. Central Asian Soc.*, Vol. 17, 1930, pp. 5–18; "Tarimbecken und Takla-makan Wüste," *Zeitschr. Gesell. für Erdkunde zu Berlin*, 1930, pp. 350–360). Schomberg, on the other hand, questions it; he believes that changes in the rivers' courses are a more likely cause for the failure of water supplies and consequent abandonment of once occupied sites than absolute loss in the rivers' volume (R. C. F. Schomberg: The Climatic Conditions of the Tarim Basin, *Geogr. Journ.*, Vol. 75, 1930, pp. 313–323). Stein, Schomberg, and Trinkler all cite instances of the deceptive appearance of climatic desiccation due to local circumstances, physical or artificial. Professor Albrecht Penck, moreover, has shown that with the loss of water due to evaporation and seepage into the ground only a "slight diminution of the river discharge" may bring about a very notable shortening of the river. "Therefore, if there are ruined places in the desert of Taklamakan even more than 100 kilometers below the actual settlements it is not necessary to assume a considerable change of climate" ("The Habitable Globe: Central Asia," *Geogr. Journ.*, Vol. 76, 1930, p. 485).

It is probable that there has been considerable tectonic uplift of the Himalaya during postglacial times, and the suggestion has been made that this uplift may have resulted in a shutting off of damp southerly winds (Trinkler, *op. cit.*, p. 360)—though whether such an effect has been appreciable during historic times is another question. If so, it might account for diminishing precipitation in the Kunlun and Tien Shan and a consequent shortening of the rivers which take their rise in these ranges. Sir

Sidney Burrard, Sir Aurel Stein (*Geogr. Journ.*, Vol. 65, 1925, p. 490), and more recently Willi Rickmer Rickmers (*ibid.*, Vol. 74, 1929, p. 213) have favored the theory that the existing glaciers of the mountain rampart surrounding the Tarim basin represent in large measure dwindling residuals of the ice of the Glacial Period and that the gradual disappearance of this "dead" or "fossil" ice may explain the progressive shrinkage of the rivers. Despite the explorations of recent years (see *Geogr. Rev.*, Vol. 21, 1931, pp. 157–161), it is obvious that these problems cannot be solved until far more extensive studies are made of the snow fields and glaciers of the mountain rim and of the rate at which uplift, if any, is taking place.

The Climate of Indo-China. As a result of coöperation between the government departments of agriculture and of meteorology, the Bureau de Climatologie et Météorologie Agricole was established after the reorganization of the Service Météorologique de l'Indochine in 1926. The first issue of the new publication, *Annales du Service Météorologique*, has also appeared recently. It contains a summary of the weather for 1928. The number of observation stations has been greatly increased, many of the new stations being installed by the directors of large plantations. Of particular importance is the creation of a series of stations along the course of the Mekong River and on the flanks of the Annamite chain. Though years will elapse before sufficient data from the new stations can accumulate to serve as a standard for determining normals, E. Bruzon and P. Carton have presented an excellent outline of the climate of Indo-China based on all data available in 1928 (Le climat de l'Indochine et les typhons de la Mer de Chine, Hanoi, 1929).

Though the climate of Indo-China is essentially tropical, there is a difference of four degrees between the average annual temperatures of Saigon in the south and Hanoi in the north. The former has two maxima of rainfall and temperature, due to its location in the lower tropics. The latter has a definite summer rainy season and winter dry season. In contrast with these, stations in the higher lands of Central Laos show a continental trend in climate. Though the average temperature of Luang-Prabàng (350 meters), in the Upper Mekong Valley, is two degrees higher than that of Hanoi, in about the same latitude, the winter temperature has been known to come within a degree of the freezing point. To the west of the Annamite chain the monsoon of Indo-China is regular in character. To the east the normal direction of the winds is deflected by the mountains. In winter the winds are predominatingly from the north, while in the summer they are from the south and east; but during the summer small areas of high pressure within the Annamite Mountains locally supplant the Pacific high-pressure area in importance. The annual rainfall and monthly rainfall maps presented, based on 1907–1928 averages, show a striking correspondence between precipitation and relief. These maps were first published in "Atlas de l'Indochine au 1,000,000e" (Hanoi, 1928).

Indo-China lies within the area of typhoons and experiences an average of seven such storms annually. The work of Bruzon and Carton represents Indo-China's first comprehensive contribution to the study of tropical cyclones. Monthly maps having the trajectories of all the typhoons of the period from 1907 to 1928 show a comparative freedom from them from January to May, the period of maximum pressure over the continent of Asia. As this is succeeded by the summer low, an increasing number of the storms continue westward instead of recurving to the north of the Philippines. Recent investigations have indicated that most of the typhoons originate farther out in the Pacific than was formerly assumed. The Japanese observatory on the Island of Jaluit (6° 8′ N., 170° E.) reports that meteorological conditions show the occurrence of typhoons west and southwest of the island, and S. S. Visher suggests the possibility that some of the Asiatic typhoons originated off the west coast of Mexico ("Tropical Cyclones of the Pacific," by Stephen Sargent Visher, *Bishop Museum Bull. No. 20*, Honolulu, 1929). Most typhoons pass near the Philippines and recurve to the north or northeast, skirting the Pacific hyperbar.

Beyond the Philippines their courses are recorded by the observatories in Shanghai, Hongkong, and Japan. Frequently typhoons have been traced from the Philippines to the west coast of North America, and some across the United States. The storms shown by Bruzon and Carton are those whose trajectories do not lie within the field of observation of the stations of the Far East, and consequently escape observation.

POLAR REGIONS

Antarctic Circumnavigation by the "Norvegia." Consul Lars Christensen's plan for the *Norvegia* expedition for 1930–1931, a circumnavigation of the Antarctic with the special purpose of making a study of the number and distribution of whales in a single season, has been carried out with remarkable success. The *Norvegia* was under the command of Major Gunnar Isachsen. The earlier part of the voyage is described by Bjarne Aagaard in "Fangst og Forskning i Sydishavet" (Oslo, 1930, Vol. 2, pp. 905–908). Leaving Cape Town on October 4, 1930, the *Norvegia* first set her course southwest to a point beyond Bouvet Island in 57° 20′ S. and on the meridian of Greenwich, from which point the circumnavigation began and continued eastward within a belt bounded roughly by the parallels of 56° and 67° S. On October 28 in 56° 7′ S. and 23° 39′ E. the existence of a reef reported in that position by a Norwegian whaler *Truls* in the spring of 1930 was definitely disproved by a sounding of 4400 meters at that point and of similar depths in the neighborhood. By November 30 the *Norvegia* was within 150 miles of the coast of Wilkes Land in longitude 135° E. From this point her course can be followed by dispatches in the Norwegian newspapers, especially the *Aftenposten*, Oslo, January 6, 17, 29, 1931, and *Sandefjord's Blad*, February 3, 1931, copies of which were kindly placed at the disposal of the American Geographical Society by Mr. Aagaard. A thorough investigation was made of the reported locations of the Nimrod group and of Dougherty Island, the former in about 56½° S. and 158½° W., the latter in the position reported by the Norwegian whaling promoter H. J. Bull, namely 59° 48′ S. and 118° 40′ W. In spite of favorable weather conditions and a thorough search no trace of land was found; indeed, the soundings in both localities exceeded 4000 meters. The *Norvegia* now steered southeast for Peter I Island, where a refuge hut was to be built and supplies left. However, ice conditions did not permit the vessel on January 4, 1931, to approach nearer than 36 nautical miles from the island. Continuing her eastward course, therefore, the *Norvegia* reached Deception Island, where she coaled on January 14. On February 7, according to a radiogram sent by Consul Lars Christensen to the Society, she was in 69° 30′ S. and 27° E. This point, in the African sector of the Antarctic, between the two new lands discovered by Riiser-Larsen last year, Queen Maud Land and Crown Princess Martha Land, represents the farthest south so far attained in this segment, exceeding the farthest advance of the *Quest* under Wild's command after Shackleton's death, when that vessel reached 69° 18′ S. and 17° 11′ E. on February 12, 1922, and sounded 1089 fathoms (1992 meters). At her February 7 position the *Norvegia* sounded 2700 meters. This sounding would seem to indicate that the margin of the continent in this longitude lies substantially south of the 70th parallel.

The attainment of this position more than closed the encircling route of the *Norvegia*. The remarkably short time in which she completed the circumnavigation—covering about 15,000 miles between her October 19 and February 7 positions—left her in a strategic position for the exploration of the 1300-mile gap of unknown coast line between Queen Maud Land and Crown Princess Martha Land, with a possible month of open season in which to carry it out. This undertaking has been entrusted to Commander Riiser-Larsen, who arrived in Cape Town on January 1 and proceeded to the *Norvegia*, presumably on one of Consul Christensen's whaling vessels, where two airplanes form part of his equipment. Hardly had he reached his field of

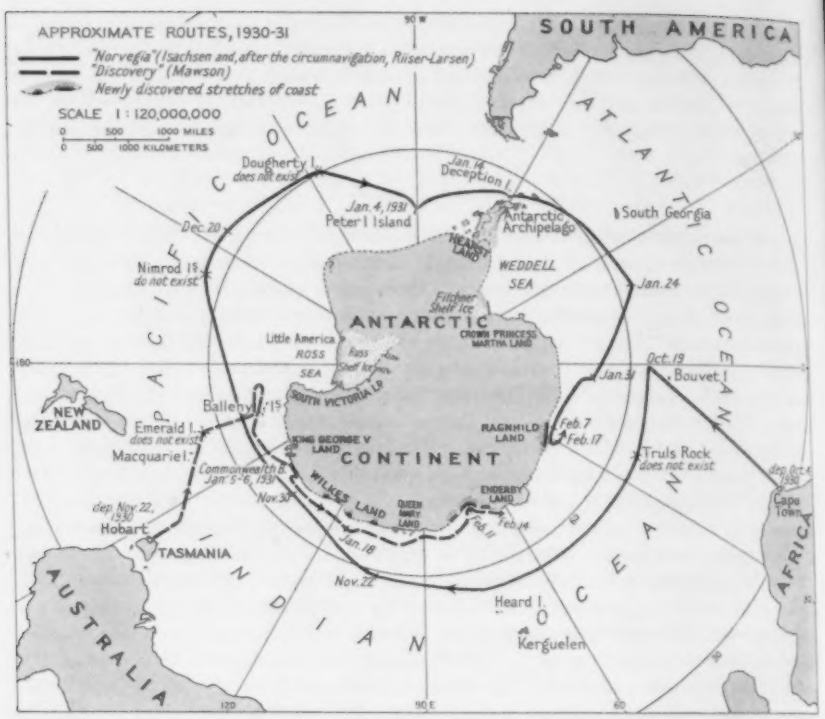


FIG. 1—Map showing the approximate routes of the Mawson and *Norvegia* Antarctic expeditions for the greater part of the field season 1930–1931.

operations when Riiser-Larsen in a wireless despatch on February 19 reported to the Norwegian Foreign Office that during flights on February 16 and 17 he had discovered and mapped from the air a new stretch of coast extending from 70° 30′ S.–24° 15′ E. to 68° 40′ S.–33° 30′ E., which was claimed for Norway and named Ragnhild Land after Crown Prince Olaf's daughter.

Prior to this, according to Consul Christensen's wireless despatch to the Society, the *Thorshavn*, on which Consul Christensen had sailed from Cape Town to visit his whaling fleet and take on oil, had met the *Norvegia* and taken off Major Isachsen, who is returning with Consul Christensen to Norway. In the course of the voyage the *Thorshavn* reached the area between Enderby Land and Kaiser Wilhelm II Land. Here in February she sounded out a bank which lies between 66° 40′ S.–75° E., and 67° 10′ S.–68° E., with soundings ranging from 750 to 162 meters, and was named Fram Bank. Mawson's sounding last year of 472 meters in the middle of the area (*Geogr. Rev.*, Vol. 20, 1930, Pl. VI) fits in well with these depths. Consul Christensen reports deeper water to the south of this bank. To supplement the work of the *Thorshavn* one of the catchers was sent farther south and discovered land and mapped the edge of the inland ice of this land in a southeastward-trending position lying between 68° 10′ S.–65° E., and 68° 50′ S.–71° E.

Progress of Sir Douglas Mawson's Antarctic Expedition, 1930–1931. Instead of approaching his field of operations from the west as he did last year (see the report in the *Geogr. Rev.*, Vol. 20, 1930, pp. 535–554), Sir Douglas Mawson this season sailed from Tasmania to work his way eastward along the coast of the Australian sector of the Antarctic Continent (see the wireless reports in *The New York Times*

beginning with the issue of December 28, 1930). The general southerly and southeasterly course took him past the southern end of Macquarie Island, over the reported position of Emerald Island, 57° 15′ S.–162° 50′ E., where soundings of 800 fathoms (or about 1500 meters) conclusively prove the nonexistence of this island, to the Balleny Islands, where the *Discovery* was to coal from a whaler. Thence the westward course was begun through the pack ice. On December 30 the *Discovery* was about fifty miles north of the coast of the Antarctic Continent in longitude 142° E. This was in waters explored by Mawson on the Australasian Antarctic Expedition of 1911–1914. On January 4, 1931, the vessel was off Cape Dennison on Commonwealth Bay, the base of the expedition of twenty years before. The magnetic hut, which was still standing, was reoccupied and a continuous series of observations made for 24 hours, which, by comparison with the determinations made on the same spot in 1912, indicated that the south magnetic pole has in the interval moved about one hundred miles closer than formerly and probably now is distant only about two hundred miles to the southeast. The British flag was again raised, and the territory between the 140th and 160th meridians was claimed for the British Empire. Incidentally, it may be remarked that the western end of this claim overlaps with the French claim of Adélie Land, whose eastern boundary is 142° 20′ E. of Greenwich.

Continuing thence west, Mawson was able from now on to skirt the coast at an average distance of seventy to one hundred miles off shore. By February 10, he had reached longitude 74° 20′ E. In this arc of seventy degrees of longitude a number of short flights were made with the airplane with which the expedition is equipped. These flights made it possible to locate approximately in five distinct places the edge of the inland ice representing the coast of the Antarctic Continent.

The positions of the sections of coast in longitudes 126°, 122°, 116°, and 107°, as reported by Mawson, when superimposed on a map showing the position of the edge of the Antarctic Continent as laid down by Lieutenant Charles Wilkes, U. S. N., on his expedition in 1840 and designated respectively North Land, Totten Land, Budd Land, and Knox Land, agree remarkably with Wilkes's outline. In general, Mawson's land positions lie somewhat farther inland than Wilkes's, but even Wilkes's implied embayments are reflected in the advanced and receded positions of Mawson's coastal stretches. When the conditions under which Wilkes operated are borne in mind, it is quite understandable that he may often have mistaken the edge of the solid pack or grounded icebergs for the real edge of the land, as was actually the case at the eastern and western ends of Wilkes's explorations in this sector, where it was Mawson himself who sailed over some of Wilkes's landfalls. Nevertheless, as has been pointed out in "Problems of Polar Research" (*Amer. Geogr. Soc. Special Publ. No. 7*, editorial footnote on page 254), it would seem a fair interpretation of Wilkes's work to say that he first outlined in their continuity the phenomena of a continental margin in this sector for a distance of 1800 miles. This interpretation is all the more justified by the fact that he himself saw the general bearing of his discoveries and was the first to recognize that the features he had observed define a land mass of continental proportions.

On February 11 the *Discovery*, continuing her westward course, entered a marked embayment apparently centered about the 72nd meridian E. and extending south beyond the 69th parallel. The coast of this embayment was followed at close range as it trended northward to merge with the coast of MacRobertson Land, discovered the year before (*Geogr. Rev.*, Vol. 20, 1930, p. 552). On February 18, a landing was made farther west, on the coast of Kemp Land in about longitude 61½°. Mawson's operations on February 11 were in the same area as those of the *Thorshavn* on February 5 and the subsequent work of the catcher (see note above). Several elements in the reports from the two expeditions fit together well; others it is a little difficult to reconcile. The western flank of the embayment reported by Mawson would seem to be identical with the edge of the stretch of inland ice reported by

Christensen; but the positions would be about seventy-five miles apart. Christensen's inland ice front lies some one hundred miles back of the position of the eastern end of MacRobertson Land as plotted by Mawson last year (*Geogr. Rev.*, Vol. 20, 1930, Pl. VI). Even Mawson's present embayment and his reported position on February 13 (67° 47′ S.–66° 56′ E.) lie far behind the coast line as he represented it last year between longitudes 66° and 74° (*ibid.*, Pl. VI and p. 543). Further details are needed to clarify the situation.

From the coast in 61½° E. the return journey was begun to Hobart, with the expectation of arriving there late in March.

Meteorology of the British Antarctic Expedition 1907–1909. The meteorological data collected on Shackleton's first Antarctic expedition have now been worked up by Dr. Edward Kidson, Director of the Meteorological Services of New Zealand (British Antarctic Expedition 1907–1909, Reports on the Scientific Investigations, Meteorology, Melbourne, 1930).

The main meteorological station was at Cape Royds, Ross Island, latitude 77° 34′ S., about seven miles north of Scott's station on Cape Evans. It lies in the path of the cold air draining from the high Ice Plateau (to the west) down to the open Ross Sea (to the northeast), and to the enormous Ross Shelf Ice (to the southeast). Owing to the topography of McMurdo Sound these cold currents appear as southerly winds at Cape Royds. When pressure changes favor the development of southerly winds this drainage is reinforced into the southeasterly blizzards of which everyone has read. At other times the cold layer over the Ross Shelf Ice produces quite stable conditions, which are not much disturbed by the occasional warm winds from the north. The weather at Cape Royds consists essentially of southeast winds (rising to blizzards), of calms, and of a small proportion of northerlies, which are seldom strong.

The results differ little from the much more complete record obtained a few years later by Dr. G. C. Simpson in the same region. The screen at the latter station was 26 feet higher and farther up the Sound. In both places the coldest weather in winter occurs during calms. Strong winds disturb the dense cold layer and raise the temperature. The northerly winds often appear colder than the southern blizzards; but, as Kidson points out, if the northerly winds can *entirely* sweep away the cold layer then the northerly winds are warmer. Shackleton, however, sometimes experienced very cold weather in blizzards, as in August, 1908, when the temperature was lower at the end of the storm. This is, however, very unusual.

The average annual temperature at Cape Royds was 3.3° F. which was the same as at Cape Evans in 1912 but 3° warmer than at Cape Evans in 1911. The Shelf Ice and the Ice Plateau reflect solar radiation away at all seasons; hence Antarctica is always cooling the air. Northerly winds carry some warmth into the continent, while the ocean is heating the air to some extent even in winter. The hottest month experienced in 1908 was December (29.6° F.); and the coldest, July (−17.1° F.).

Kidson, however, believes that the loose snow on the Ross Shelf Ice (which he calls by its old name, the "Barrier") stores a considerable amount of heat during the summer. This varies from year to year and perhaps helps to explain the rather large amplitude of diurnal variation of temperature at Cape Royds in the summer months. Pressure and wind variations also affect the diurnal temperature variation especially in winter. The highest temperature was 47° F. on December 10 and the lowest −43.5° on August 19. Interesting readings on the *Nimrod* show that in the summer of 1909 there was a "cold layer" of air over McMurdo Sound, which drifted onto it from the Ross Shelf Ice.

Records of temperatures taken on sledging expeditions are given. The flow of wind down the Beardmore Glacier exercises a strong effect on the temperatures. Its turbulence produces a rise in temperature by driving away the cold layer on the Shelf Ice. On January 7 and 8 very cold air was encountered on the Ice Plateau in

spite of strong winds. Kidson suggests it came from some very cold area on the other side of the continent.

The winds were much less violent than those recorded later at Cape Evans. The average for the year was 10.8 miles an hour. In May the velocity rose to 62 miles an hour for several hours. The most usual direction was from the southeast, the next usual being from the north. On the south Polar plateau the *sastrugi* (snow ridges) were from a southerly direction. On the Plateau near the magnetic pole there were two sets of *sastrugi*, one from the southeast and the other from the west. As regards upper-air movements the results agree with those at Cape Evans. The smoke from Mt. Erebus (13,000 feet) was almost always from the southwest, thus differing greatly from the direction of the surface winds.

Precipitation is difficult to measure. The Taylor Glacier across McMurdo Sound seems to be in a district practically without snowfall, but Sir Edgeworth David, to whose interest in the meteorological work much credit is due, deduced that the snowfall was perhaps equivalent to nine inches of rain a year at Cape Royds. On the Shelf Ice snow was deposited on an ancient depot at about the rate of seven and a half inches (of rain) a year. About six inches of ice a year was removed by ablation from small lakes at Cape Royds.

At Cape Royds in 1908 the lowest pressure occurred in the cold months of June (28.994) and September (28.942). Yet, if the Antarctic is dominated by an anticyclone, Kidson says that the *highest* pressure might be expected in winter. Hence in his opinion it is the polar cyclone (not the anticyclone) which controls the annual variation. But, owing to the height of the enormous plateau, pressure distribution is much complicated in Antarctica.

Regarding the pressure waves, which Simpson discussed at great length, the Cape Royds data give a mean length of each wave at 150 hours, and the variation .50 inches. Kidson believes that the weather so far described at McMurdo Sound may be far from an average sample. He discusses pressure waves in Australia, where he thinks they form permanent structures. About eight of these waves occur in a circuit of the globe. They provide the mechanism whereby heat is transferred from the equator to the pole. He links them up with Bjerknes' Polar Front theory but is unable at present to state how closely the Antarctic resemble the Australian "waves." He believes that pressure waves initiate rhythmical outrushes (or strophs) and that the waves themselves arise in tropical and subtropical rather than in polar latitudes.

The average height of the Ross Shelf Ice is taken to be 228 feet, which is much higher than that deduced by Simpson (170 feet). It is harder to deduce the height of the Ice Plateau from aneroid and hypsometer data. Kidson's results differ little from those obtained by Simpson. At 86° S. both deduce a height of 8500 feet; at 87° S. Simpson shows about 9400 feet, and Kidson 9600; at 88° S. Simpson gives about 9800 feet, and Kidson 9900 feet.

GRIFFITH TAYLOR

PHYSICAL GEOGRAPHY

Ocean Waves. The study of ocean waves is one of peculiar complexity. It does not lend itself readily to experimental investigation; the mathematical treatment is both involved and abstruse; and direct observations in the open sea are obviously matters of difficulty, especially in the case of storm waves. In spite, therefore, of the importance of the subject in connection with shipping, but little progress has been made for a number of years.

In an article under the title "Sea and Swell" (*Marine Observer*, Vol. 7, 1930, pp. 106–113) H. Keeton summarizes briefly the existing knowledge on the subject. Examining the observational data received during the past four years at the Marine Division of the British Air Ministry, he finds that the accepted relations between

the length, velocity, and period of ocean waves may require modification. Of fifty measured observations of swells and eleven of waves, all but two had velocities considerably less than calculated from the accepted formulae. Apparently, too, it may be necessary to revise upward the accepted heights of storm waves; for Keeton lists a number of recent observations of waves 50 to 70 feet in height.

A number of islands in the Atlantic Ocean are subject to swells known as "rollers." These break with violence on the shore, and during the period in which they manifest themselves landing is extremely dangerous. Keeton discusses the rollers of Ascension and St. Helena and the related storm waves of the Bay of Rio de Janeiro where they are known as *resacas*.

H. A. MARMER

HUMAN GEOGRAPHY

World Illiteracy. Various criteria have been suggested as measures of a nation's culture: Professor Jefferson in his most recent essay at rating the world's civilization

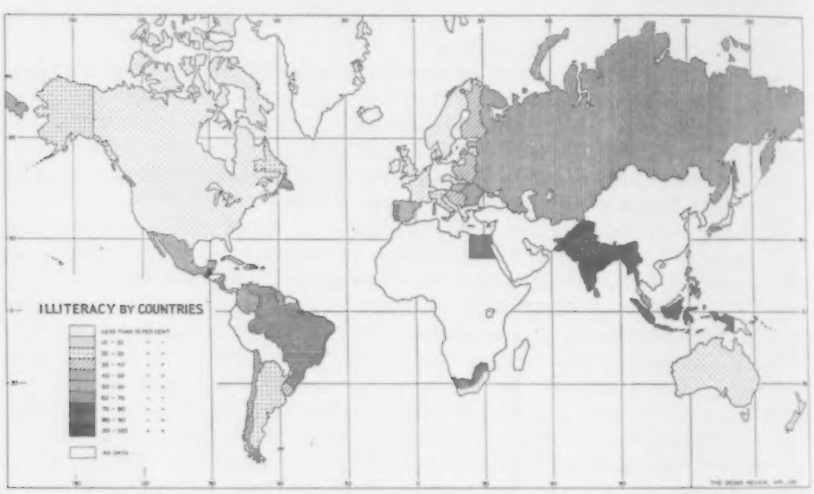


FIG. 1—Map of the world showing percentage of illiteracy by countries.

(Exercises in Human Geography, 1930, pp. 105–109) uses as indices schools, communications, cities, patents, and trade. As a variant of the first of these, the providing of schools, one might employ degree of literacy, data for which have recently been prepared by the United States Bureau of Education (James F. Abel and Norman J. Bond: Illiteracy in the Several Countries of the World, *Bur. of Education Bull., 1929, No. 4*). The findings are summarized in a series of maps on which Figure 1 is based. Admittedly the sources employed were unsatisfactory; even where census statistics were available—for half the people of the world only—they are based on such different criteria as scarcely to be comparable. For example, in the United States the illiteracy percentage is figured on the count of all inhabitants over ten years of age; in Australia an indigenous population of 59,000 is not counted. Furthermore, official definitions of the term "illiterate" are various—a matter of some importance, as in the Philippine Islands, where 25 per cent of the persons who can read Spanish cannot write it. The realignment of European boundaries after 1919 resulted in some interesting illiteracy inheritances. Whereas the illiteracy rate for Poland as a whole is about 32.8 per cent, that for the former Russian sections ranges from 30 to 71 per cent, for the former Austrian sections from 19.4 to 46

per cent, and for the former German sections from 2.5 to 5.2 per cent. In the case of Greek Macedonia, scene of continuous conflict during the World War and subsequently of the exchange of great masses of people, the illiteracy figures reflect too transitory a condition to be employed.

The World's Salt. Salt is one of the most ancient commodities of commerce. A host of place names are silent reminders of a salt industry that once flourished where now there is no trace of it. The relations of Early Iron Age culture to the distribution of salt deposits have been noticed in many places and have recently been pointed out as being particularly clear in the piedmont of the French Pyrenees (E. E. Evans: The Pyrenees, in "Studies in Regional Consciousness and Environment," [London,] 1930, pp. 53–54). By its nature salt is adapted to the formation of monopolies, which were particularly powerful until the coming of the steamship and the railroad. This was true, for instance, in France, where during the sixteenth and seventeenth centuries the salt trade was active, the product from the Atlantic coast going to the fishers of the north and that from the Mediterranean going to Switzerland (Henri Hauser: Le sel dans l'histoire, *Rev. Écon. Internatle.*, 19th Year, Vol. 3, 1927, pp. 270–287).

The world's salt production today (1928) is given by the Imperial Institute as approximately twenty-six million tons (The Mineral Industry of the British Empire and Foreign Countries: Statistical Summary, 1926–1928, Imperial Institute, London, 1929). Three-quarters of it is produced in the United States, Germany, Russia, China, the United Kingdom, France, and India—the annual output of each of these countries reaching well over the million ton mark. The United States, with a total production of over seven million tons, of which the states of Michigan and New York furnish over one half, is by far the world's greatest producer. It is both mined as rock salt and obtained from brine. Germany's production comes largely from rock salt, and Russia obtains about half of hers from lakes and the rest from rock salt and from natural brines connected with the deposits. The chief producing centers are Lake Baskunchak in Astrakhan, Bakhmut in Ekaterinoslav, Bereznikov, a section of the Urals, and the Donetz Basin. The resources are capable of expansion in many localities, but the limiting factor hitherto has been lack of transportation facilities (The Mineral Industry of the British Empire and Foreign Countries: Salt, Imperial Institute, London, 1927).

China's salt supply, which is a government monopoly, is produced from wells and from the evaporation of brine. Wells, sometimes reaching 3000 feet, are developed to exploit the rock salt deposits of Szechwan and Yunnan. Lakes also supply some of the salt, but probably between seventy-five and eighty per cent comes from the "sea salt fields" of South Manchuria (the largest salt-producing region of China), Hopei, Shantung, Kiangsu, Chekiang, Fukien, and Kwangtung. In the west, subsidiary industries have sprung up, such as the manufacture of horn and bone articles, utilizing the carcasses of buffaloes, which cannot long stand the strenuous work at the mines. (B. P. Torgasheff: Salt in China and Elsewhere, *Chinese Econ. Journ.*, Vol. 4, 1929, pp. 476–497; Wallace Crawford: The Salt Industry of Tzeliutsing, *China Journ. of Sci. and Arts*, Vol. 4, 1926, pp. 169–175, 225–229, 281–290; Vol. 5, 1926, pp. 20–26; The Salt Wells of Szechwan, *Chinese Econ. Monthly*, Vol. 3, 1926, pp. 519–526; *Chinese Econ. Journ.*, Vol. 1, 1927, pp. 70–79; The Salt Administration of Chekiang, *ibid.*, Vol. 4, 1929, pp. 45–52.)

In Indo-China the salt industry is a seasonal occupation flourishing in the dry season and primarily in the coastal salt marshes, particularly in southern Annam and Cochin China. Tongking and northern Annam by their climate are less well adapted to the preparation of salt. The product is of particular importance to the fishing peoples of the coast (Le sel en Indochine, *Annales Inst. Colon. de Bordeaux*, 1928, pp. 112–116).

India produces about seventy per cent of the great quantity of salt consumed by her and imports the rest. The areas depending chiefly on the imported article are Bengal, Bihar, Assam, and a large part of Burma, where there is a demand for a fine, white crushed salt which the Indian market has not yet been able to supply. The question of the salt revenue in India is not a new problem. In the middle of the last century a "salt wall," or customs line, patrolled by some 12,000 men and composed chiefly of "thorny trees and bushes, supplemented by stone walls and ditches, across which no human being or beast of burden or vehicle could pass without being subject to detention," extended for 2500 miles from a point north of Attock to the borders of Madras (K. N. Haksar: The Salt Revenue and the Indian States, *The Asiatic Rev.*, Vol. 25 (N. S.), 1929, pp. 7–16).

In Ecuador salt is also a government monopoly, and importation is not permitted except under special conditions. Most of the supply comes from salt deposits near Salinas. The narrowness of the margin of supply is shown by the fact that in 1926 a heavy storm flooded and temporarily put out of commission many of the local salt deposits with the result that a serious shortage was felt throughout the country but most of all at those points farthest from the railroad.

OBITUARY

Otto Sverdrup. Six months after the death of Nansen, Norway has lost another of her distinguished explorers, Otto Neumann Sverdrup, who died at Oslo on November 26, aged 76 years. Captain Sverdrup's name is closely associated with that of Nansen in his greatest geographical exploits—the first crossing of Greenland in 1888 and the drift of the *Fram*, 1893–1896. "I knew that I could not place the *Fram* in better hands," says Nansen, describing the offer of the command to Sverdrup: and how splendidly was that trust confirmed by the safe return of the ship after the leader had left her for his sledge journey over the ice! It was only a short time after the return to Norway that Sverdrup again took the *Fram* northward, on this occasion leading an eminently successful expedition to the American Arctic Archipelago. The second *Fram* expedition wintered there four years, 1898–1902, and explored an area of some 100,000 square miles chiefly in Ellsmere Island and the new islands discovered in the vicinity—Axel Heiberg, Amund Ringnes, Ellef Ringnes, and King Christian islands. The important scientific results, including the maps by Gunnar Isachsen, cartographer of the expedition, were published as "Report of the Second Norwegian Arctic Expedition in the *Fram* 1898–1902" (4 vols., Videnskabs-Selskabet i Kristiania, Kristiania, 1907–1913); the narrative of the expedition was given by the leader in the two volumes "New Land" (London, 1904). Sverdrup claimed the new land for his country, and it was only a few days before his death that Norway, admitting the fact of effective Canadian occupation, formally recognized Canadian title to "Sverdrup's Islands." At the same time the Canadian government acquired by purchase the original maps, notes, diaries, and other relative documents of a work of exploration that has been "most useful to the Department of the Interior and the Royal Canadian Mounted Police, in their annual patrols" (*Natural Resources Canada*, Dec., 1930, p. 4).

Captain Sverdrup was a master of ice sledging and of ice navigation, and his expert advice and assistance were frequently sought. In 1914 at the request of the Russian government he commanded the *Eclipse* on a search expedition to the Kara Sea for the Russian explorers Brusilov and Rusanov. He wintered on the northeastern side of the Taimyr Peninsula and collected valuable data on the region. Again in 1920 he was engaged for the rescue of a Russian vessel wrecked in the Kara Sea and in 1921 led a commercial expedition along this northern route, five vessels trading to the Ob and Yenisei (see *Geogr. Rev.*, Vol. 13, 1923, p. 309). His advice was also enlisted in the search for Nobile.

José Toribio **Medina.** José Toribio Medina, the well known Chilean historian and bibliographer, died at Santiago December 11, 1930, in his seventy-eighth year. For many years Dr. Medina had been recognized as a leading authority on the early history of Hispanic America. In more than half a century of research in Spain and the Latin-American countries he brought to light more original documents on the discovery, conquest, and early colonial life of Hispanic America than any other person. So varied were his interests and so tremendous the list of his published works that it is possible to mention only a few of them here. To students of Latin-American history and geography he is perhaps best known for two out of his many bibliographical publications, his "Biblioteca Hispano-Chilena" in three volumes and his great "Biblioteca Hispano-Americana," of nearly 10,000 titles, in seven volumes. He was, however, much more than a bibliographer. Much of our present knowledge of the early discoveries in South America is due to his indefatigable labors in Spanish and Latin-American archives and his publication of many of the original documents first brought to light by his hands. Worthy of special mention among these is Carbajal's manuscript on "Orellana's Discovery of the Amazon River." Besides his work in listing and publishing such original documents are his studies of colonial life in Hispanic America, especially his numerous publications on the development of printing and on the Inquisition. His chief literary work is his great edition of Ercilla's epic poem "La Araucana," in which he is said to have studied more than 500 original documents in addition to his earlier research and travels in Araucanian territory in connection with his book "Los aborigenes de Chile."

At the time of his death Dr. Medina was engaged on a study undertaken at the request of the American Geographical Society of a manuscript map covering the coast of southern Mexico, Central America, Ecuador, and parts of Colombia and Peru recently discovered in Peru and believed to date from the sixteenth century. The results of his study were to have been published in the *Geographical Review.*

GEOGRAPHICAL REVIEWS

Minerals and Politics

C. K. Leith. **World Minerals and World Politics: A Factual Study of Minerals in Their Political and International Relations.** xii and 213 pp.; diagrs., index. Whittlesey House, New York, 1931. 7¼ x 5½ inches.

This book is a timely review by the chairman of the newly created Mineral Inquiry of the American Institute of Mining and Metallurgical Engineers. Dr. Leith, by wide experience and long study, is specially qualified for the task of presenting a clear summary of the present knowledge of this subject so intimately bound up with "the future orderly development and peace of the world." Any review of a book which itself is a condensed review necessarily covers only some of the features of the work with the possibility of distortion through condensation. An idea of the tenor of Dr. Leith's book may be gained by quotation from the fundamental facts and tendencies which it develops.

The magnitude of the world's output of minerals and the rapidity of present-day utilization is generally unappreciated—"more mineral resources have been mined and consumed since the opening of the century than in all preceding history" and the "demands for raw materials would in time reach fantastic figures impossible of realization" were it not for improvement in technology. For example "the rapidly widening use of steel alloys requires less weight of steel and therefore of iron ore," and better methods of extraction and utilization have vastly increased our available reserves of coal and oil, which is particularly important because the fuels are entirely destroyed when used and do not, like the metals, have a constantly increasing quantity in the form of scrap available for recovery and re-use.

"When all the low-grade and high-cost deposits are taken into account, world supplies are ample for a very long time, with the possible exception of gold and oil," says Dr. Leith—and in the opinion of the reviewer oil should not be included in this category. The problems that arise are consequently not those growing out of the imminent exhaustion of natural sources but primarily those due to irregularities in geographic distribution and in richness and size of deposits.

The different kinds of mineral deposits are so irregularly distributed that "in regard to mineral supplies there is no such thing as equality of nations." "Not even the most favored nation is entirely self-sustaining in minerals, nor can it be made so." International movement of minerals is a world necessity, "in fact nearly a third of the world's mineral tonnage moves across international boundaries (of this third, coal, oil, and iron constitute the great mass)." Attempts to interfere with the international movement of minerals along the lines that have been predetermined by their geographic distribution are not only foredoomed to ultimate failure but are productive of unnecessary and harmful international friction. "A striking feature of post-war changes in the European mineral situation has been the tendency to restore the pre-war functioning of the industries based on natural groupings of raw materials, regardless of new political lines. The political dismemberment of these groups under the Peace Treaty has proved, on the whole, a commercial failure. Much needless loss and friction might have been avoided if the distribution of raw materials and the industries based upon them had been taken into account when the terms of peace were settled, instead of the consideration solely of the racial, linguistic, historical, and geographic conditions. Political adjustment to remedy this mistake is already in evidence."

The special concentration around the North Atlantic of the raw materials primarily necessary for large industrial developments, namely fuels and iron ore, has been one of the most important factors in the creation of the industrial power of the North Atlantic countries. "World History since the industrial revolution has demonstrated the necessity of industrial power as a basis for political and military supremacy under modern conditions," and "there is little promise of similar growth elsewhere because of the fundamental deficiencies in raw materials. The continued political and military preponderance of the North Atlantic region seems to be indicated for the future."

"The Far East produces a rather imposing aggregate of minerals," but "the sources are scattered among so many nations that they do not constitute an adequate basis for independent industrial development." "The pooling of the mineral resources of all the Far East, such as they are, would probably do more toward physical betterment of the Far Eastern peoples than any other commercial measure now in sight. The problem is a large and difficult one, both commercially and politically. Commercial interests are already studying the problem and are even making moves toward cooperation. On the other hand, the political movement just at present is toward disintegration."

One of the inevitable consequences of the highly irregular distribution of mineral resources among nations is that wherever important mineral deposits exist and are not developed the world's needs will sooner or later force their development. "The manner of exploitation may be controlled or modified, but the necessity of exploitation cannot be eliminated. To dismiss it as unethical, or undesirable, or unnecessary, as if it were a mere matter of political will, as is sometimes attempted, merely postpones the time when it must be objectively studied and intelligently controlled."

"There is general agreement that unification of the industry is an essential step in conservation, that the more important conservational measures are possible only under unified control, as has been proved by advances already made." "In fact, an impartial review of conservational measures which have been put into effect shows that by far the more numerous and effective ones have been initiated by the industry itself in its striving for higher efficiency." "Commercial integration can never go far enough to eliminate private initiative, even if it were desired. There are too many thousands of small mineral deposits and too much unexplored ground to be controlled by any commercial combination."

In some respects Dr. Leith's book shows the effects of condensation; for example it says, under the heading "Germany," "The potash industry is entirely under control of the German government"; and one might infer that this is in consequence of the preceding statement that in Germany "all subsoil minerals are the property of the nation" with the sole limitation that "two states have rights to coal and salt." It happens that the ownership of minerals in Germany varies greatly in different parts of that country, owing to the differing laws and customs of the several states and districts that formed the German Empire and whose laws and customs with respect to minerals were preserved in the union. Much of the potash development in Germany is in a district where the potash is the property of the surface owner, and the operations are carried on by leases or other arrangements with the surface owners, not by the province or nation. Among other examples attention may be drawn to the very clear and illuminating table summarizing graphically "the position of some of the consuming countries with reference to the principal minerals" and in which "black dots indicate by their position the extent to which the country in question is able to supply its needs of the mineral in question from within its own political boundaries." One wonders whether the dot for petroleum in the case of the United States has not strayed into column C of "minerals inadequate to meet domestic demands, partially dependent on foreign sources." The United States is producing more petroleum than it consumes; and, as the author points out, better

methods of extraction and utilization have "vastly increased our available reserves of oil." With reference to the world's resources of oil, the reviewer feels that the author is inclined to underestimate them. On the other hand, he greatly overestimates the effect that the restriction in our Leasing Act has had in Latin-American countries when he says: "Our strong American oil companies . . . have received powerful aid in certain countries by the invocation on the part of our government of the reciprocal clause in our Leasing Act."

In preparing a clear, readable, compact, yet comprehensive outline of the present knowledge of minerals in their world relations, and of many of the intricate and conflicting political problems, both national and international, growing out of the present-day hugely accelerated use of minerals Dr. Leith has not only added impetus to the work of the Mineral Inquiry Committee and similar technical committees abroad but has given to the ever-increasing number of those interested in world affairs a more comprehensive and well-rounded insight into one of the fundamental factors connected with international relations than they could obtain in any other way in the time required carefully to read this volume.

A. C. VEATCH

A CHAPTER IN CANADIAN ECONOMIC HISTORY

HAROLD A. INNIS. **The Fur Trade in Canada: An Introduction to Canadian Economic History.** 444 pp.; map, ill., index. Yale University Press, New Haven, 1930. $5.00. 9 x 6 inches.

"The Fur Trade in Canada" takes rank as a work of major importance on Canada and its author as an authority on Canadian affairs. The book reveals a matured objective—to trace the history of the fur trade as it spread across the continent of North America. The organization of the book fits the purpose, and the text fits the organization. The study begins with the fur trade on the Atlantic coast and progresses westward to the Pacific via the Ottawa country, the Great Lakes, Hudson Bay, and the area tributary to the Saskatchewan. The analysis also progresses chronologically, for the development in each of the areas discussed represents an important period in the history of the industry. The author, therefore, keeps the reader oriented in both the areal and chronological dimensions of his survey. The book is authoritative, for it is based on primary sources and brings to light much material not previously available. A large part of this material is introduced into the body of the text, and all of it is admirably documented. Deductions and conclusions are based on discriminating analysis and synthesis, while the alert clarity of the author's style carries the reader through the mass of detail necessitated by the scholarly character of the work. The author is a political economist, and his book betrays a gratifying allegiance to the discipline he represents. He emphasizes, for example, the results of the contact of the maturely organized economic institutions of Europe with the primitive economic order of the Indian tribes. At many points in the book the analysis is carried beyond the periphery of the major discipline. The scholarly nature of the work is revealed by the fact that, without even an approach to the academic, the author recognizes these necessary excursions into the field of geography, sociology, or other bordering disciplines.

Furthermore, Dr. Innis' book is more than a treatise on the fur trade of Canada. It is, in fact, a revealing interpretation of the development of Canadian economic life. The author holds to his subject consistently but nevertheless brings out the relation of the fur trade to other industries and institutions. He shows, for example, how the Hudson's Bay Company came to be associated with the Grand Trunk Railway, how the men who built the Canadian Pacific had served with the Hudson's Bay Company, and how the Bank of Montreal was organized and staffed by leaders in the fur trade. He shows also the important rôle played by the fur trade at the

time of the American Revolution and how the great organizations, flung across the continent by the fur trading companies, were of immense significance at the time of Confederation.

CHARLES C. COLBY

A PIONEER STUDY IN HOME-STATE SOCIAL ECONOMICS

SAMUEL HUNTINGTON HOBBS, JR. **North Carolina: Economic and Social.** xviii and 403 pp., maps, diagrs., index. The University of North Carolina Press, Chapel Hill, 1930.

North Carolina has more farms and a larger farm population than any other state but Texas; no other state has fewer cultivated acres per farm or per person living on farms. "In other words, we come nearer approaching the European conditions of hand and knee farming" than elsewhere in the United States. Since nearly half of the farmers (45.2 per cent) are tenants, "the greatest single economic problem in North Carolina and throughout the South" is that of farm tenancy. Although North Carolina ranks high in the *production* of wealth (largely by virtue of her manufacturing industries, in which she leads the South), in the *retention* of wealth she makes a poor showing, ranking about forty-first among the states in wealth per inhabitant. "The truth is that there is a vast army of relatively poor people in North Carolina," and wealth is highly concentrated in the urban areas. Per capita wealth, however, is increasing rapidly, along with industrial development and urbanization, and North Carolina "is gradually becoming a better balanced state"; in the past she has been "top-heavy on the rural side." There are too many counties; greater economy and efficiency could be maintained if some of the remoter rural counties were consolidated. In spite of recent advances in public education North Carolina is exceeded by only two states in the percentage of illiterates in the population. Illiteracy is especially prevalent in the extreme rural sections and areas of maximum farm tenancy. There is also much "near-illiteracy." One hundred thousand farm families read next to no current magazines and newspapers, and four-fifths of the country people read no books, except, perhaps, trade catalogues, almanacks, and occasionally the Bible.

These random observations from Professor Hobbs's book show that he does not hesitate to call a spade a spade. His purpose is to give a true picture of North Carolina as it is today, not a picture that will please the boosters. He ranks his state forty-third among the forty-eight states of the Union—not fifth as one agency of the State government would have it. This judgment is based upon a comparison of the ranks that each state holds in sixty-three "important economic and social concerns" (such, for example, as bank savings per capita, percentage of illiterates, infant death rates, inhabitants per motor car, percentage of population served by public libraries, farm wealth produced per worker, etc.). In this classification California heads the list, New York is fourth, and Alabama forty-eighth. Although Professor Hobbs would probably be the last to maintain that his method of ranking is without a flaw, in the face of the figures no one could possibly argue that North Carolina stands either to the fore or even in a middle position among the states. Perhaps, however, were it possible to rank her in terms of recent *progress* rather than of present status, she would take a higher place. Remarkable has been her advance in many fields: notably highway construction, public education, health administration, wealth. Mortality has been reduced from a high level to "exactly the average for the registration states, in spite of the high death rate among negroes." Professor Hobbs's book, therefore, does not leave us pessimistic about North Carolina's future. Its publication is indeed a favorable omen if it means that this great state has taken to heart the Greek maxim that to "know thyself" is the highest wisdom. Would there were such a book for every state!

Flood Studies in the New England-New York Region

H. B. Kinnison. **The New England Flood of November, 1927.** *U. S. Geol. Survey Water-Supply Paper 636-C*, 1929, pp. 45–100.

Maine Rivers and Their Protection from Possible Flood Hazards. [Report] to the Maine Development Commission by G. W. Mindling, P. L. Bean, B. L. Hopkins, J. A. Leonard, T. W. Clark, M. R. Stackpole. 90 pp.; diagrs., index. Augusta, Me., 1929. 9 x 6 inches.

E. S. Cullings and Allen Hazen. **A Report on the Control of Floods in Northern New York Rivers** (to a Committee representing the Mayors of the Cities and Villages of northern New York). 55 pp. The New York Development Association, Inc., Watertown, N. Y., 1928.

These three papers by experts in hydraulic engineering present in compact, well illustrated form their views regarding lessons to be drawn from the great Vermont-New Hampshire flood of 1927. Furthermore, they come at a time when hydro-electric power development in New England is affecting both the imagination and the pocketbook of the average citizen.

Alike in scientific approach, and consistent in their conclusions, they differ in emphasis on principles as well as in regional scope. Kinnison's paper is primarily a report of run-off, determined by field measurements immediately after the flood; but in addition there is a fourteen-page analysis of the flood-producing rainstorm (based upon articles by Weber, Brooks, and Goodenough), six pages of historical material on previous storms and floods (from Barrows and Pierce), and ten pages of discussion of damage to highways and bridges (by Clark, McNary, and Jarvis of the Bureau of Public Roads). The figures of flood flow are of particular interest and not elsewhere available.

Tables show maximum discharge and total run-off for 13 river basins at 134 points. In the meteorological section the most striking feature, perhaps, is Figure 8, where hourly rainfall and consequent run-off on a flashy headwater at Northfield, Vt., are combined on one chart. A large map of New England showing distribution of rainfall during the floods of 1927 and 1869 and location of gauging stations (scale 1 : 1,000,000) goes as far in the use of isohyetal lines as the run-off measurements alone seem to warrant but takes little account of the White Mountains as an area of heavy rainfall.

The group of papers on flood control of Maine rivers includes a sixteen-page article by George W. Mindling, government meteorologist, on maximum rainfall probabilities in Maine, separate reports on the Saco, Kennebec, Penobscot, Androscoggin, and St. Croix rivers by hydraulic engineers conversant with conditions in the respective basins, and a summary by Paul L. Bean, Engineer in Charge.

Natural storage and heavy forest cover are probably larger factors in Maine than in any other New England state; but these are shown to be highly irregular in distribution and of more service on some systems than others. In the Penobscot basin, for example, which occupies over one quarter of the area of the state, lakes are scattered almost everywhere and are of all sizes; but there are too many of them to permit simple organization of regulated flow. Most of these lakes are dammed, and are likely to be full when heavy rains come. It is not economical to increase dams and reserve extra height for emergency storage. The report closes with an emphatic plea for more storage reservoirs, even though these are located and built primarily for power development. "These two uses of storage reservoirs [for power and for flood control] when intelligently operated, materially reduce the peaks of floods to reasonably safe limits and probably function as a flood protective measure with nearly as much efficiency as if they were used for flood control alone. In other words, the amount of water which has to be released during flood periods is small

highest wisdom. Would there were such a book for every state!

and comes at a time after the peak of the flood has passed at points below." While this statement may apply to Maine, it is rather too sweeping if applied to northern New England as a whole; for there are critical points (for example at Fifteen Mile Falls on the Connecticut, just above its junction with the Passumpsic) where release of stored water during the approach of a flood might cause dangerous combination of high water on two branches where nature, let alone, fails to synchronize. Such exceptional cases, however, only support the argument that authority to regulate both storage and release of water, at all points on river systems, should be vested in an experienced engineer, working in coöperation with the several power companies and other interested users of water and municipal engineers. Rivers are large, complex mechanisms; and they can only be controlled by concerted and scientific action.

Of the three reports, the one dealing with northern New York is perhaps the most interesting reading. Pictures show not only the spectacular behavior of floods in Vermont and upper New York State but clearly indicate how the encroachment of industrial plants and city streets, bridges, and buildings upon channels scarcely wide enough under their original natural conditions forms a menace to communities along these rivers.

On the basis of rainfall figures and meteorological study of storm tracks, it is concluded, first, that northern New York may at any time get a storm like that which deluged northern Vermont in November, 1927, though perhaps not oftener than once in a century. Also it is pointed out that great storms do not come evenly spaced but are haphazard. One may prepare for the worst, but he cannot foresee when the benefits of his preparation will be realized. The two largest factors in causing floods from the Adirondacks are storm rainfall and melting snow cover. Either one alone is sufficient to give bad floods; the two factors often combine; but no combination has occurred since the settlement of the region when either factor had its maximum value.

Allen Hazen, who computes the maximum flood flows for seven rivers west and northwest of the Adirondacks, observes that "The land along any river may be divided into three parts: (1) the river channel, which all agree ought not to be encroached upon, (2) the middle ground, usually dry, but sometimes flooded, and (3) highlands above all floods." To adopt as the highest flood the "memory of the oldest inhabitant . . . is a very simple method but not always adequate." There is "no such thing as a maximum flood. Instead there is a succession of floods of every varying size. There is a flood of such a size that it may be expected to occur on an average once in ten years. . . . These floods are not evenly spaced. In fact it often seems as if they were grouped . . . "

The forty-odd pages prepared by Cullings are clear and rapid and as well organized as the flood flow of a regulated river. Questions are put and answered, with ample support from figures. There is no tendency to minimize the seriousness of flood hazard nor to omit local, specific illustrations of it. The treatment is scientific, impartial, and vigorous. While conclusions are based on measurements, there is explicit admission that the factors which create floods are so variable that a change here or there, in any particular case, is bound to reduce or magnify the result.

In the consideration of what may be done to reduce danger and losses from floods in northern New York, emphasis, again, is put upon reservoirs on headwaters. There is a brief but interesting discussion of reservoirs in general, in which the diverse uses and kinds are enumerated, from fire protection reservoirs, which are always kept full, to retarding basins, which are always kept empty except when functioning. The ideal, for this region, the river-regulating reservoir, should be so manipulated as to be empty when a flood is approaching and full at the beginning of a drought, with its level varying and under control about nine-tenths of the time. That kind of reservoir combines economic benefits with scenic value and recreational use.

J. W. GOLDTHWAIT

Symposium on Hungary in Italian

S. Bátky, A. Berzeviczy, and Others. **L'Ungheria.** viii and 454 pp.; maps, ills. *Publs. Ist. per l'Europa Orientale*, Ser. 2, Vol. 18, Rome, 1930. 9½ x 6½ inches.

Sixteen Hungarian scholars, every one a specialist in his own field, have collaborated in the production of this book which aims to present to the Italian reading public a comprehensive picture of the Hungary of today as viewed from every angle. Hence individual papers deal with the geography, ethnography, history, language, literature, art, music, science, and public instruction as well as with the political and financial situation.

This is a "book with a purpose," and its purpose is most succinctly expressed in a quotation from Louis Kossuth: "Hungary has great need of Italy, but I venture to declare that Italy also has great need of Hungary." The first part of the book—written by Albert Berzeviczy, President of the Hungarian Academy—deals with the intimate historical relationships between Hungary and Italy. The ratification by both parliaments of the pact of friendship made between the two nations in 1927 was but the culmination of a thousand years of such close contacts as have almost nowhere else existed between two nations unrelated by blood and not adjacent in territory. Many of the other papers emphasize the benefits that would accrue to both countries from an even firmer alliance. There is no great power save Italy on which Hungary may rely to gain her lost possessions taken from her by the Treaty of the Trianon. Italians are reminded that in the event of international complications Hungary's geographic position and the fighting qualities of her soldiers would make her no mean ally.

Apart from this purpose of propaganda, the principal significance of the book is due to the fact that it is the first comprehensive survey of Hungary made a decade after the dismemberment of the country by the Treaty of the Trianon (see in conjunction "Hungary Before and After the War in Economic-Statistical Maps," edited by A. E. Illés and Albert Halász, Budapest, 1926, and "New Central Europe in Economical Maps," by Albert Halász, Budapest, 1928). During the chaotic condition of the country after the World War it was freely predicted that Hungary had no chance of survival. Yet the papers on the financial and political situation point out that already a fair degree of stabilization has been secured. It would be well to begin the reading of the entire book with the paper by Anthony Éber on the financial situation, which concludes as follows: "Through the benevolent support of foreign powers the financial situation of Hungary has shown a constant improvement ever since the crisis of 1925. This financial recovery is making possible the complete restoration of the country as it emerges from the difficult reconstruction period."

Geographical problems are dealt with in the papers by S. Bátky and Count Paul Teleki. In the former the question of the settlement of Hungary—i. e. pre-war-Hungary—is discussed. There have been two principal periods of assisted immigration into Hungary. The first was during the centuries that followed the Magyar Conquest of 896. Vast regions of uninhabited land and primeval forest fell to the lot of the conquering Magyars. The Árpád kings encouraged settlers from the West, Germans, Italians, and others, and gave them exceptional privileges. At the same time Rumanian shepherds from Wallachia wandered over the mountains and settled in Transylvania. The second period of immigration was after the country had been freed from a century and a half of Turkish domination. The fertile regions of the southern Alföld had become largely a wilderness. The policy of the government in dealing with this situation led to a great settlement of other nationalities in the devastated region.

Count Teleki points out that Hungarian cities are of two types. There are the great cities of the Alföld which served as refuges for the rural population during

the Turkish invasion. Even now a great many persons go out daily from them to attend to their agricultural work. In many respects these "giant villages" lack the characteristics of true cities. On the other hand there are many cities in Hungary that are situated on the borders of natural divisions—where the plains reach the low hills or where the foothills pass over into mountainous regions—and owe their development to the commerce once carried on between the people of the hills and those of the plains. The Treaty of Trianon has separated these commercial centers in most cases from their hinterland and has thus caused very grave economic difficulty.

E. D. BEYNON

VEGETATIONAL INDICES OF CLIMATIC TYPES IN EUROPE

Oceanic, Continental, Mediterranean and Boreal Climatic Influences and Mountain Climate in Europe as Synthetised and Represented by Characteristic Plants. Compiled . . . by Count Paul Teleki and Zoltán de Nagy. 11 pp. of text (10 x 7 inches) and 7 maps (13½ x 9½ inches). (Publs. Geogr. Inst. of the Econ. Faculty of the University of Budapest, No. 1.) Budapest, 1930.

Certain plants, such as the olive, for instance, have frequently been used as indices of particular climatic types. Professor Paul Teleki of the University of Budapest has extended the scheme, using it to delimit some half dozen climatic types of Europe. Separate symbols on the maps show the distribution of each vegetational type and their overlapping results in a gradation of shading which represents the transition zones to the true climatic type which appears darkest. Among the maps, there is one entitled "Warm Atlantic Climatic Influences." The map showing the Continental Influences is accompanied by six small maps showing the migrations of the peoples of the steppe belt of eastern Europe since the birth of Christ. Interesting relations between geographic and historic facts are thus made possible. For example, the author points out that the four successive homes used by the Magyars in their migration from the Urals were entirely confined to the intensely continental climatic areas. The vegetation maps are extremely interesting and suggestive of a wide field of study as yet scarcely touched.

W. O. BLANCHARD

STATISTICAL ATLAS OF POLAND

Rzeczpospolita Polska Atlas Statystyczny (La République Polonaise Atlas Statistique). xv pp. of text and 42 plates of maps and diagrs. Central Statistical Office of the Polish Republic, Warsaw, 1930. 17½ x 11 inches.

The Central Statistical Office of Poland planned to issue this atlas upon the occasion of the tenth anniversary of the restoration of the independence of Poland. However, numerous obstacles arose which delayed its appearance.

The table of contents indicates the specific years for the data used in the construction of the maps and graphs; some general comments upon the scale of the maps and other aspects of the atlas are presented, and a few detailed remarks for each page of plates follow. The dates for the maps and charts range from pre-war years to 1929, a variance which detracts somewhat from the value of the atlas so far as concerns comparisons which a reader might wish to draw. However, it seems to have been unavoidable. Some other improvements, which no doubt will be cared for in the next edition, could be made with advantage. For example, immediately following the first map, which is a general political map of Poland, scale 1 : 2,000,000, there is a density-of-population map (Pl. 2) and then a combination pie-diagram and map (Pl. 3) to show urban population distribution according to political subdivisions whose names are not given. Not until we reach Plate 4 do we come upon maps that can be used as index maps for the major political divisions, and Plate 6 for the minor divisions. A better arrangement could be worked out.

The color scheme on the whole is good, but the reviewer feels that it would be materially improved if the vivid purple or lavender on certain plates in the front part and again in the latter part of the atlas were replaced by more pleasing shades or entirely different colors. In a few instances the color register is not good, the extreme instance occurring in the map on Plate 40.

Geographers will be pleased to have available this abundance of interesting data, easily read and in general effectively presented. One cannot help being again reminded that the United States and more especially the states of our republic still trail our European friends in the matter of comprehensive atlases of the type they have so ably produced.

EUGENE VAN CLEEF

THE HUMAN ELEMENT IN ECONOMIC GEOGRAPHY

STEN DE GEER. **Människans och Näringslivets Geografi.** 326 pp.; maps, diagr., ills., index. Bokförlaget Natur och Kultur, Stockholm, 1928. 9 x 6 inches.

In this little book the author presents his philosophy of economic geography in a popular vein, popular not in a light or cheap sense but in a manner readily understood. In the first part attention is challenged by the new emphasis laid on the subject. Economic geography has customarily been treated from either the commodity or the regional point of view: the tendency of authors to give little attention to the human aspects of the subject is deftly criticized. Without apology to any of the special fields upon which he may draw or into whose domains he may in some measure enter, Sten De Geer here takes the stand that political conditions, religion, language, and even tradition are vital elements of the human environment and that they must be taken into full account in a treatise on economic geography. Recognition of cultural landscape as well as natural landscape is made without reserve, and in this book the former rather than the latter is emphasized.

The treatment is twofold, with the relationship of human geography to be got by deduction rather than by direct statement. Five chapters constitute the human geography, and through them the author outlines the essential aspects of the cultural environment in their relations to and as a setting for economic geography. Their headings suggest the scope of the discussion: I. Population, Size and Distribution; II. Increase of Population; III. City Growth; IV. Quality of Population; V. Human Organizations. The last-named is political geography but not of orthodox pattern. There the author treats countries historically and with reference to location, form, and types of political organization—all concisely, but laying no direct claim upon geographic influence in accounting for them.

The second half of the book consists of commodity studies. They are well written but so brief and varied that one is inclined to doubt their power to impress themselves upon student minds. To treat the resources of land and sea, of forest and mine, as well as all phases of transportation and communication in less than 200 pages is indeed an Herculean task.

NELS A. BENGTSON

A TEXTBOOK ON ASIA

L. DUDLEY STAMP. **Asia: An Economic and Regional Geography.** xx and 616 pp.; maps, diagrs., index. E. P. Dutton & Co. Inc., New York. [1929²]. $8.00. 9 x 6 inches.

"The basal structure of Asia is different from that of the remaining continents: moreover, as the principal land mass of the globe, Asia deserves to be studied *de novo*." In these words the author states his objective on the opening page of the book. The 604 pages of text that follow afford convincing proof not only that he has accomplished a real *de novo* study of Asia but that the continent does indeed possess a unique individuality.

There has hitherto been such a dearth of geographical material on Asia as a whole that this volume, which represents a pioneer attempt to produce a much needed college textbook, is eagerly welcomed. Its particular value lies in the fact that it presents under one cover a great range of material otherwise available only in scattered form. The value of the book is greatly enhanced by numerous footnote and chapter references. In addition, the book makes a genuine appeal to the non-academic reading public, for it is written with pleasing clarity. While the author at times becomes slightly encyclopedic, he exhibits an unusual ability to make bare facts interesting. In part this is due to an unobtrusive humor and optimism, but rather more to vigorous phraseology and unstilted expression.

On the other hand, the author is weak in his ability to evaluate data; he has striven to touch too wide a range of material even at the risk of becoming tedious, rather than selecting data that are relevant to the creation of ideas of some magnitude. Herein lies the principal pedagogical weakness of the book. The facts have not been marshaled in such manner as to evoke major problems or to waken in the reader's mind a geographical philosophy. There is little attempt to show the adjustment of man to environment. However, while ultimate analysis is absent, Dr. Stamp's work is saved from being wholly descriptive by a consistent element of proximate analysis.

The volume is profusely illustrated by 324 maps, diagrams, and graphs. Some startingly vivid and effective results have been achieved by the various cartographical devices employed; the map of Palestine (p. 116) and that of Java (p. 407) may be cited as random examples. The book is in two parts. Part I deals with Asia as a whole. Part II, comprising by far the larger portion of the work, covers systematically the individual countries of Asia, each country being treated topically rather than analytically.

The subtitle of the book, "An Economic and Regional Geography," is of doubtful value and probably should have been omitted, since it gives an erroneous idea of the scope of the work. Particularly is this evident when the book is weighed as a regional geography. In most instances a section devoted to natural regions is included under each country, but the author does not employ these natural regions as bases on which to group the social phenomena and ecological relations of mankind within a country. No very consistent basis seems to have been employed for the delimiting of regional units: they are variously orographic, hydrographic, climatic, or merely locational in nature. The reader feels the lack of a large coördinated regional map of Asia as a whole.

As an economic geography the book is likewise open to some criticism. The treatment of Japan may be taken as an example: the author presents a rather complete sketch of the seismology, volcanology, and other physical aspects of the country; but his discussion of the economic activities is scarcely adequate. Regarding the immensely significant industrial adjustments in Japan, he remarks (p. 550) "It is unnecessary to stress the westernization and industrialization of Japan—these are too familiar to require emphasis." Yet these items, together with regional geographic economy, the strategy of men, meat, and lands, the evaluation of geographical location, commercial penetration and expansion, interregional relationship, and others of like nature, would appear to be the very essence of economic geography.

The author has spent many years in residence in Asia, a circumstance that renders patently authentic his treatment of the southern portion of the continent. On the other hand, it has peculiarly overbalanced the book in favor of the areas with which he is most familiar. Practically 40 per cent of Part II is devoted to India and Ceylon, whilst Japan, which is probably the most significant country in Asia, is allotted but 38 pages. Similarly, the Nicobar and Andaman Islands receive four pages to Manchuria's eight pages.

The book is a veritable mine of information and possesses real literary merit, but these assets do not entirely compensate for the author's lack of any clear-cut geographical philosophy, his failure to achieve a balanced perspective, and the ineffectiveness of his regional treatment. Upon first examination, American geographers have hoped that Dr. Stamp's "Asia" would answer their textbook needs as Jones's "South America," Smith's "North America," Taylor's "Australia," and others of their kind have done. While it is probably satisfactory for classroom work in British colleges and universities, in the reviewer's experience it is not likely to prove adapted for use in a similar capacity in American schools. Its ultimate function will probably be that of an indispensable reference and source book for the library shelf.

G. T. RENNER

THE ATMOSPHERIC CIRCULATION OVER AUSTRALIA

HANS VOGEL. **Die atmosphärische Zirkulation über Australien.** Maps, bibliogr. *Mitt. Geogr. Gesell. in München*, Vol. 22, 1929, pp. 181–237.

Australia has much of unusual interest for the meteorologist and climatologist. It is a fairly symmetrical land mass, large enough to include marked continentality of climates in its interior, and it has many marine features along its coasts. It has one of the great trade wind deserts at its "dead heart," with sufficient rainfalls on its windward seaboard. It has monsoons on the north and subtropical or Mediterranean conditions on the south. It presents some very individual cyclonic and anticyclonic types. It combines, in one continent, within a reasonably small area, a large number of varied meteorological phenomena and climatic types. Furthermore, the Australian meteorological service has during many years past given us a very considerable number of excellent publications. In addition, others not connected directly with the official government weather service have done their shares, for instance, Professor Griffith Taylor, formerly of the University of Sydney and now at the University of Chicago, who has contributed notable studies on the economic and human climatology of that continent.

A recent contribution to the literature is in German and embodies an intensive schematic study of the characteristics and habits of the cyclones and anticyclones of that region. The results of the schematic treatment are applied to the varying conditions of the atmospheric circulation over Australia throughout the year. Three fundamental types of pressure are found to control the weather: anticyclonic, northern, and southern depressions. These are illustrated by means of isobaric maps. Rainfall, which is of such fundamental importance in the life and economy of Australia, merits and receives special attention in the discussion of the mechanics of the atmospheric circulation. It appears, according to the author, "that the circulation over Australia shows pure planetary conditions. All phenomena find their explanation in the disintegration of the (tropical) high pressure belt into individual anticyclones, which cross Australia in a steady procession."

The monograph is divided into four parts: the essential facts of atmospheric circulation in the subtropical high pressure belt of the southern hemisphere; the circulation over Australia in the course of the year; individual examples of weather types; and the monsoons of northern Australia. The tracks followed by cyclones and anticyclones are plotted for individual months, and the behavior and relations of the high and low pressure areas are analyzed, with special reference to lines of atmospheric convergence and surfaces of discontinuity. There follows a discussion of the general seasonal progress of atmospheric circulation throughout the year, with emphasis on conditions that bring rainfall. Selected type-weather-map situations are shown in somewhat over thirty small sketch maps. The monsoons are discussed in the last eight pages.

R. DEC. WARD

Antarctic Physiography and Related Problems

Olaf Holtedahl. **On the Geology and Physiography of Some Antarctic and Sub-Antarctic Islands, with Notes on the Character and Origin of Fjords and Strandflats of Some Northern Lands.** 173 pp.; maps, diagrs., ills., bibliogr. (Scientific Results of the Norwegian Antarctic Expeditions, 1927–1928 and 1928–1929, instituted and financed by Consul Lars Christensen, No. 3.) Norwegian Acad. of Sci., Oslo, 1929. 11 x 7 inches.

W. Campbell Smith, edit. **Report on the Geological Collections Made During the Voyage of the "Quest" on the Shackleton-Rowett Expedition to the South Atlantic & Weddell Sea in 1921–1922.** xii and 161 pp.; maps, diagrs., ills., index. The British Museum, London, 1930. 12s. 6d. 10 x 6½ inches.

These two exhaustive reports, covering much the same field of investigation, have conveniently, although undesignedly, made their appearance at practically the same time. Dr. Holtedahl visited Antarctica in the southern summer of 1927–1928, but his report also includes descriptions of islands, based on photographs, etc., that were visited by the *Norvegia* expedition of 1928–1929 of which he was not a member. In the other volume under review the British Museum (Natural History) authorities have published reports by numerous writers on the geological collections made during the voyage of the *Quest* in 1921–1922, a voyage rendered tragically memorable by the death of its leader, Sir Ernest Shackleton, in South Georgia just as the major work of the expedition was beginning.

The most important work in both reports concerns the geology of South Georgia and its bearing on the tectonics of the South Atlantic region. Tyrrell, in the *Quest* report, and Holtedahl both discuss what Holtedahl calls the "South Antillean Arc Problem." E. Suess, in his "Antlitz der Erde," promulgated the view that South Georgia forms part of a great eastwardly-directed loop of folding which, emerging from Tierra del Fuego and Staten Island, runs through the Burdwood Bank, South Georgia, curves round on itself in the arc of the South Sandwich Islands, and returns westward through the South Orkney Islands, the South Shetland Islands, and Graham Land. This loop is supposed to connect the tectonic lines of the Patagonian Andes with those of the Antarctandes of Graham Land, just as the similar island loop of the Antilles connects the tectonic lines of North and South America. Professor J. W. Gregory and other British geologists have combated this view on tectonic, paleontological, and petrological grounds and have preferred to see in South Georgia and the other islands the remains of an ancient continental land, the Flabellites Land of Schwarz. On the basis of the new evidence, especially of the Mesozoic age of the Cumberland Bay Series of South Georgia, which now seems to be established, and its resemblance to certain Mesozoic rocks in the Patagonian Andes, Holtedahl renders support to Suess's original view, which is also supported by O. Pratje on the basis of the ocean floor contours of the region revealed by the echo soundings of the recent German *Meteor* expedition. Tyrrell holds that the geological and paleontological evidence is still too scanty and equivocal to be decisive for the settlement of the problem. It should be stated, however, in favor of Suess's view, that Thule Island, one of the South Sandwich Islands, contains lavas of typical Andean characters, as shown by the study of a new rock collection.

The greater part of Holtedahl's memoir is concerned with the topography, physiography, and glaciation of the regions visited by him. Such a mass of material is arranged under locality headings that it is impossible to summarize in this place. Besides South Georgia, Clarence Island and the nearly extinct volcano of Deception Island are treated in considerable detail. In his general remarks on the glaciation Holtedahl introduces a new type of glacier, which he calls the "Antarctic ice-mantle type." This type seems to combine many of the features of the "highland ice" and "island ice" of Wright and Priestley's classification of glacier types. It is

defined as the type produced when the ice covers the whole of an island land mass down to sea level but is not of great thickness, every undulation of the underlying terrain being registered by the ice surface.

In the long concluding part of the memoir Holtedahl turns to the consideration of the characters and origin of the fiords and strandflats of some northern lands, Norway, Spitsbergen, and Novaya Zemlya, comparing them with the coastal topographic features of the Antarctic. In regard to the moot question as to whether fiords are of tectonic or glacial origin, Holtedahl makes some shrewd criticisms of the view of J. W. Gregory and Gerard De Geer, namely that there is a causal connection between the northern fiords and Cenozoic crust movements in the same region. He remarks: "We find the most typical fiords in a highland where the existence of old river-cut valleys brought about a concentration of ice erosion along certain, narrow zones and where an underground of hard, yet jointed rocks favoured the development of an angular design and steep walls, and probably also of a marked bottom relief with great depths" (pp. 144–145).

The *Quest* Expedition Report emphasizes the geological and petrological rather than the physiographical aspects of the subject. About half the report deals with the collections made in or near the Antarctic regions; in the other half, collections from various Atlantic islands—the Tristan da Cunha group, Gough Island, St. Helena, Ascension Island, St. Vincent (Cape Verde) Island, and St. Paul's Rocks are described; also the results of deep-sea deposits and dredgings.

The petrology and geological implications of the isolated St. Paul's Rocks in the Central Atlantic are dealt with by Dr. H. S. Washington. These islands constitute the only known instance of a truly oceanic island that is composed entirely of ultrabasic igneous rock of plutonic aspect (peridotite). The rocks, moreover, show signs of pressure and are almost certainly metamorphosed. The nature of St. Paul's Rocks has a very important bearing on the origin of that remarkable geographical feature known as the Central Atlantic Swell (or Rise or Ridge). In another paper, The Origin of the Mid-Atlantic Ridge (*Journ. Maryland Acad. of Sci.*, Vol. 1, 1930, pp. 20–29), Dr. Washington expresses the view that the peridotite of St. Paul's Rocks represents a sample of the floor of the Atlantic Ocean squeezed up by lateral pressure, in the region of known greatest instability and of seismic and submarine volcanic activity in the Atlantic Basin. To account for this region of unusual crustal instability, and the remarkable bend in the course not only of the mid-Atlantic Ridge but also of the Atlantic itself, Dr. Washington is inclined to apply Prinz's little-known hypothesis of differential torsion as between the northern and southern hemispheres.

G. W. TYRRELL

GREENLAND IN PICTURE AND NATIVE SONG

T. N. KRABBE. **Greenland: Its Nature, Inhabitants, and History.** xvi and 129 pp. of text; 170 plates; map, ills., bibliogr., index. (In Danish and English.) Levin & Munksgaard, Copenhagen; Humphrey Milford, London, 1930. 40s. 12 x 9½ inches.

WILLIAM THALBITZER. **Légendes et chants esquimaux du Groenland.** Ouvrage traduit du danois par Mme Hollatz-Bretagne. 188 pp.; ills., bibliogr. (Collection de Contes et Chansons Populaires, Vol. 45.) Librairie Ernest Leroux, Paris, 1929. 7 x 4½ inches.

Krabbe's book pictures Greenland—inhabited Greenland—in 170 plates ranging from the bleak northern outpost at Thule to the idyllic scenes of the wooded Kingua Valley in the south. The plates are accompanied by explanations and 129 pages of text, Danish and English in parallel columns, which give an outline of the country, its people, and its history. The text is further embellished with portraits of eminent

men, Danes and others, who have figured in that history. The admirable preface tells precisely what the reader wants to know about the author and his "claim to publication." During the period 1889–1909 Dr. Krabbe spent eleven years in Greenland as resident medical practitioner and the rest of the time as traveling medical officer. He himself took all the photographs, and this at a time of special interest, just before the rapid development and changes of recent years. The photographs are all dated, another praiseworthy feature of a well conceived work.

Wholly delightful is Thalbitzer's small volume—"a little anthology of all kinds of Greenlandic poems . . . the first complete picture of the folklore of old Greenland, while yet virgin of European influence." "And how curious," he continues in his introduction, "to find among these wild rocks a poetic source so rich and living." The first and major part of the book deals with the Angmagssalik Eskimos, among whom the author carried out his own particular researches (*Meddelelser om Grønland*, Vols. 39 (1914) and 40 (1923)). It includes kayak songs, songs of the mountain and berry picking, lullabies, nursery songs, duel and drum songs, songs of the magicians, and magic formulas. West Greenland is chiefly represented by a number of legends. This part of the country has had a long contact with Europeans, but many of the legends preserve memories of the ancestral life. Four modern songs also are included. Though the translators disclaim any attempt to do more than give a literal version of the Eskimo texts, some of the renditions are truly charming, Number 29, for instance, "L'étoile qui tombe." Certainly they have succeeded in conveying something of the "soul of this primitive language," and thus of country and people.

The Hobbs Greenland Expedition

W. H. Hobbs. **Exploring About the North Pole of the Winds.** viii and 376 pp.; maps, diagrs., ills., index. G. P. Putnam's Sons, New York and London, 1930. $5.00. 9¼ x 6½ inches.

In reading this very interesting and beautifully printed book, one is apt to lose sight of the real accomplishment of the expedition. In the closing chapter Professor Hobbs merely mentions the fact that in the two preceding years 776 pilot balloons were sent up, reaching an average altitude of about four miles. This is a notable accomplishment, worthy of a much more elaborately equipped station in a less rigorous climate. The seasons covered, the frequency of the flights, and the facts disclosed by the soundings are reserved for another volume, which students of Arctic meteorology await with keen interest, particularly in view of the similar work being done by the British and Germans.

At the present time, in addition to the reconnaissance surveys, daily radio reports are sent of observations from five base stations: Julianehaab at the southern tip of the island, Angmagssalik and Mygbugten on the east, and Godthaab and Godhaven on the west coast, so that both Europe and America are able to keep close watch on the changes in pressure, wind, and weather taking place over South Greenland.

What the Hobbs Expedition will disclose is as yet uncertain, but we shall eagerly welcome any light it may throw on two important problems: (1) the deflection into Davis Strait of cyclones leaving the American storm zone and (2) the formation of lows in the region of strong temperature contrasts southeast of Greenland.

While speculation over the results to be disclosed adds interest to the present volume, it is well able to stand alone because of the picture it draws of the difficulties to be overcome before any serious accomplishment can be expected from Arctic exploration. In general, these are glossed over; but enough remain to show how much must be done before the base of operations is ready for the proposed survey. The book deals principally with the regions around Holstensborg on the coast and Mt. Evans (1294 feet), about 80 miles inland and 30 miles west of the ice cap.

Students of air routes across Greenland will receive many impressive suggestions. the clearness of the atmosphere making possible the splendid series of pilot balloon observations; the snowstorms referred to as beginning before the close of August; the fogs along the Labrador coast; the skirting of thousands of rocky islets and half submerged reefs on the Greenland side of Baffin Bay and Davis Strait; the treacherous and gusty winds sweeping down fiords off the southwest coast; the föhn character of these winds, lasting two or three days, and their dark terraced clouds; the persistent outflow of air from the ice cap; the dust blown from the glacial clays, and the rapidly moving lows that pass through Davis Strait from the Newfoundland area.

Much must be learned of these and other features before this northern route can receive serious consideration as an airway between Europe and America.

JAMES H. KIMBALL

COMPARATIVE STUDY OF CITY LANDSCAPES

SIEGFRIED PASSARGE AND OTHERS. **Stadtlandschaften der Erde.** vi and 154 pp.; maps, diagrs., ills., bibliogrs. Friederichsen, de Gruyter & Co. M. B. H., Hamburg, 1930. M. 8. 9½ x 6 inches.

Passarge has again blazed a new geographical trail. As he points out in his preface, urban geography has attracted a great and rapidly increasing interest in recent years, yet there has been no attempt to establish a comparative study of the cities of the different parts of the world. The book aims, he says, to further interest in urban geography and to bring together materials from the countries which the several writers have visited personally. In this, the work is amply justified. Each of the nine contributing authors is a geographer of merit. No set system of study or presentation was used, however, and each investigator approached his problem according to his own judgment and inclination. The result is a collection of somewhat different ideas as to the content and method of urban geography. The philosophy of the individual writer is either deliberately presented or can be readily ascertained in most cases. In this, possibly, lies the chief value of the book. Every article is rich in qualitative data; and, although many important parts of the world are omitted, a beginning is made in a general "comparative city landscape study." It is regrettable, however, that there is a complete absence of quantitative data which are necessary before a scientific comparison can be made. The nearest approach to this type of data is found in the numerous maps and sketches of city street patterns, but unfortunately these are omitted from several of the articles. Then, too, the lack of a uniform approach, although exceedingly valuable in suggestion, makes comparison most difficult. But, as Passarge points out, a norm may be reached in the future.

The first article is by Max Eckert and contains a short but interesting statement of the antiquity and development of the cartographical representation of city landscapes. Credit is extended to Hermann Wagner for first demanding that the importance of the surrounding area, as well as the detail of the city proper, should be mapped. Konrad Frenzel points out that studies have been chiefly concerned with the situation, site, and the horizontal and vertical structure of the city. The chief goal of geographic study, he believes, should be toward the relationships between the landscape and the inhabitants of the area. There follows a valuable study in the geography of certain German cities of the Middle Ages.

Otto Jessen classes the Spanish city as belonging to the general southern European type but having in addition an Oriental aspect. Different climatic and other natural conditions have led to regional variation. The Spanish city has maintained its ancientness to a surprising degree but is beginning to change before the advance of machine culture. The study emphasizes chiefly the ground plan or horizontal structure but does not ignore other aspects. Particularly valuable is the consideration

of the tempo, or momentum of activity, and the hourly rhythm of city life. In treating of Russian city landscapes Arved Schultz nowhere loses sight of the dual influences—nature and history. Nine classes of cities are considered in terms of their historical development, structure, and geographical distribution. House types are likewise described and interpreted.

Passarge, personally, writes on the city landscapes of the Arabian Orient. All cities, he says, are artifically made culture landscapes. All cities have the same fundamental purpose, and all men have the same fundamental needs. Hence, if we analyze the city landscape we have adequate data for comparative study. In the Arabian Orient there is an unusual agreement between landscape and culture. The natural environment, city structure, and city character development are emphasized. Descriptions of several Chinese cities are given by no less authority on things Chinese than Heinrich Schmitthenner. It is to be regretted that no exact statement is given of the author's point of view, as the method of approach differs often from one city study to another.

Australian cities, says Walter Geisler, are English cities but differ from those of the motherland in consequence of their extreme growth. The site and situation and plan of the city, the house forms, and the building material are the chief interests of the author. Bruno Dietrich writing of North American cities is chiefly concerned with grasping the "American idea," and he analyzes New York City as the acme of it.

Ludwig Mecking believes that in the Japanese city landscape culture is all-important. The differences in the natural environment between north and south, coast and inland are as great as between middle and southern Europe, yet in general Japanese cities are all alike. In general, this statement is true, but a closer observation of detail should have been made. Considerable emphasis is laid upon ten divisions of population agglomerations into shi (city), machi (town), and mura (village). Such a division is government-determined according to definite criteria and is valid if only size is considered. A misunderstanding of the mura seems to have been made again. The mura is not an agglomeration but is an area under one government office and is divided into smaller areas, azas and ōazas, each of which contains one or more agglomerations. The general distribution of population and agglomerations commands a good deal of attention. The lack of old buildings and the great changes that take place in city structure are rightly attributed to the frequent occurrence of fires. The strict adherence to one-family houses, he points out, is the reason for the wide extent of Japanese cities. Numerous keen observations are made on gardens, types of traffic, entertainments, etc.

Excellent bibliographies accompany some of the articles and constitute one of the outstanding features of the book. In some cases they are found as annotation. In others, they occur in alphabetical order at the end of the article. Another feature of lasting value is the inclusion of many city maps and sketches.

ROBERT BURNETT HALL

RECENT GEOGRAPHICAL SCHOLARSHIP IN GERMANY

Hermann Wagner Gedächtnisschrift: Ergebnisse und Aufgaben geographischer Forschung. 391 pp.; maps, diagrs., ills. *Petermanns Mitt. Ergänzungsheft No. 209*, 1930.

This volume was first planned as a testimonial to the dean of German geographers on the occasion of his ninetieth birthday, June 23, 1930. Unfortunately Professor Wagner's death on June 18, 1929, made necessary the change from "Festschrift" to "Gedächtnisschrift."

The book includes thirty articles by contributors chosen from among those "who either through the trend of their work or through personal relations had been brought

into close contact with Hermann Wagner." So many were Wagner's pupils, so wide his scholarly contacts, and so profound his influence (see *Geogr. Rev.*, Vol. 20, 1930, pp. 166–167) that it was thought fitting to conceive of the book as an informal survey of the present condition and problems of geographical research in Germany.

About a third of the papers are primarily explanations of methods or points of view that their authors regard as desirable in geographical research. Norbert Krebs, for instance, estimates needs for and limitations in the use of exact measurements as a basis for the classification of land forms and climatic areas. Siegfried Passarge explains his concept of *Landschaftskunde*, involving the differentiation of regional types (*Landschaftsräume*) by the application of well defined physiographic, vegetational, and "cultural" criteria. Erich von Drygalski presents a scheme for subdividing and grouping ice forms. Max Eckert makes a plea for cartography as a scientific discipline (*Lehrfach*). He claims a high degree of scholarly dignity for maps constructed according to scientific principles. The making of a map, he says, "may often demand more science, more care, and more mature thought than a philological exegesis, or the most minute and conscientious of textual criticisms, or a chemical analysis." Ernst Tiessen argues that in maps of economic geography clarity and the effective picturing of the whole are more important than the representation of a multitude of details. He suggests possibilities and warns against dangers in the cartographic representation of statistical data. Different procedures in research in economic geography are advocated by Nikolaus Creutzburg, Otto Schlüter, and Ludwig Mecking respectively in papers on economics and the region (*Landschaft*), on commercial geography as a "pure" science, and on the geography of seaports.

Other contributions are, in the main, critical discussions of the progress of research in particular branches of geography especially as carried on in Germany or by German scholars. For example, a critique of city geography is given by Hans Dörries. That an amazing amount of work in this field has been done in central Europe during the past two decades is demonstrated by an impressive array of footnote references. Eugen Oberhummer points out profitable avenues of investigation in the geographical study of languages. The position and problems of historical geography in Germany are outlined by Walther Vogel; and Konrad Kretschmer, as a brief introduction to a consideration of medieval world maps, reviews German contributions to our understanding of medieval geography and cartography. A paper by Karl Sapper describes the present status of the cartography of Central America, and Hermann Lautensach estimates work that has been and ought to be done in the regional geography of Portugal.

Ten or twelve papers deal with specific problems in geography itself rather than with problems in research and methodology. Physical geography and climatology are represented by considerations of the constitution of the earth's interior, of Pleistocene movements of the earth's surface in central Germany, of certain surface forms in Chile and Spitsbergen as throwing light on the "comparative morphology of climatic zones," of movements of climatic regions during the last glaciation, of the exchange of waters between the North and Baltic seas, and of the theories of the tides in the North Sea. Hinrich Engelbrecht describes the primary agricultural regions of the earth and gives a colored map showing the distribution of nine types of agriculture. Albert Herrmann reconstructs the geographical work of Ptolemy's predecessor, Marinus of Tyre.

American readers will turn with particular interest to papers by Georg Friederici and Max Hannemann. Friederici, writing on the "penetrability" of North America during the epoch of discovery and exploration, shows, on the basis of contemporary records, that the forests of the East and of the Mississippi Valley offered no serious obstacles to the advance of the early explorer and pioneer, contrary views of De Tocqueville and others notwithstanding. In the primeval woodlands of most of our continent there was little undergrowth, and travel was about as easy as on the open

plains. Friederici describes different regional types of forest in their relation to "penetrability." Hannemann explains recent changes in the distribution of the negroes in the United States, particularly those resulting from the migration of the last twenty years to the industrial centers of the North and South. His paper is illustrated by two original maps based on the census returns. One map differentiates between counties and cities having absolute and relative increases or decreases in negro population between 1910 and 1920; the other shows for the same period the absolute amount of increase in the number of negroes in counties and cities of over 25,000 population.

We cannot attempt to characterize or even to list all the papers in the Wagner "Gedächtnisschrift," but, perhaps, enough has been said to give some idea of the volume as a whole. The vitality and productivity of contemporary German geographical scholarship are manifested through its pages.

Aleppo to Basra in the Eighteenth Century

Douglas Carruthers, edit. **The Desert Route to India: Being the Journals of Four Travellers by the Great Desert Caravan Route between Aleppo and Basra 1745–1751.** xxxvi and 196 pp.; map, ills., bibliogr., index. London, printed for the Hakluyt Society, 1929. 9 x 6 inches.

An old caravan route once led from Aleppo to Basra, keeping well out in the open desert to the west of the Euphrates. This track was followed by not a few Europeans during the sixteenth and early seventeenth centuries and again in the middle of the eighteenth. "Desert conditions were then very much as they are to-day—unstable. Bedawin nomads periodically raided the sedentary riverine tribes. But there was one great difference: whereas now there is a sort of central zone, or no-man's land, between 'the desert and the sown,' in those days powerful Arab confederacies held power right up to the Euphrates and had their strongholds . . . on the river itself. Therefore the 'desert route' for a long section of its length lay wholly within their sphere."

Eighteenth century British narratives of journeys made over this route have been preserved, four of which are published in the present volume. Of these, two, by William Beawes, 1745, and Gaylard Roberts, 1748, are here printed for the first time from manuscripts in the library of the India Office. The others, reports of journeys made by Bartholomew Plaisted in 1750 and John Carmichael in the next year, were first published in 1757 and 1772 respectively. These narratives, with Mr. Carruthers' historical introduction and notes, illumine a chapter in the history of "British Routes to India" not covered by Professor H. L. Hoskins in his scholarly volume of that title (see *Geogr. Rev.*, Vol. 19, pp. 520–521).

Beawes, Plaisted, and Carmichael give many details about their experiences and the country traversed. Carmichael, a particularly careful observer, took compass bearings and kept tally of distances by counting his camel's paces. "Over the sections which have been worked out and tested against the most recent maps, his survey does him great credit." Moreover, to him "belongs the credit of being the first Englishman to appreciate" the wonders of the mighty medieval stronghold of Ukhaidir, "to have the initiative both to explore it, and to attempt a detailed description of the ruins."

Roberts' brief report contains the following remarks: "Near all that has been wrote by those who have journalized this way, has been that they set out such an hour in the morning, pitched their tents such an hour in the evening, that the ground was stony, or uneven, in some places gravel, sand, or level in others, that they met with pretty good water in some places, bad in others, and often got hares or antelopes, which the Arabs knock down with their sticks." This is likewise true of many a modern record of desert journeys. But, while such details may bore the general

reader, they are not without value to the geographer and map maker, and to the man who follows in the "journalizer's" footsteps.

Towards the close of the eighteenth century the desert route gradually fell into disuse. At the present time it is all but forgotten, and sections of it run through country that is almost wholly unexplored.

Chinese Country Life

John Lossing Buck. **Chinese Farm Economy: A Study of 2866 Farms in Seventeen Localities and Seven Provinces in China.** xii and 476 pp.; maps, diagrs., ills., index. (The University of Nanking and the China Council of the Institute of Pacific Relations.) The University of Chicago Press, Chicago, 1930. $5.00. 9 x 6½ inches.

"Chinese Farm Economy" is a comprehensive survey of farm management, tenancy, crops, population, food consumption, and standards of living on 2866 farms scattered in seventeen localities in seven provinces of northern and eastern China. Although these studies cover but a small part of the Chinese scene, about which the author recognizes that it is particularly difficult to generalize, they furnish one of the first solid foundations for an understanding of the country life. The total area surveyed measured 21,000 acres, with a population of about 17,000. The average farm measured five acres and involved a capital investment of $1769. The average per capita earnings were $52.19 a year, with a minimum average of $23.67 in one district. Double cropping is quite general and serves to increase the effective size of the farms. The population density per square mile of cultivated land in northern China was found to be 621 and in eastern China 839, the difference being due to the shorter growing season, lower rainfall, and generally poorer soil in the north. Detailed population studies show that the present rate of increase is sufficient to double the population in 70 years.

The author modestly states that the book is not planned for the general reader, but it will assuredly be of interest to all students of the Orient.

George B. Cressey